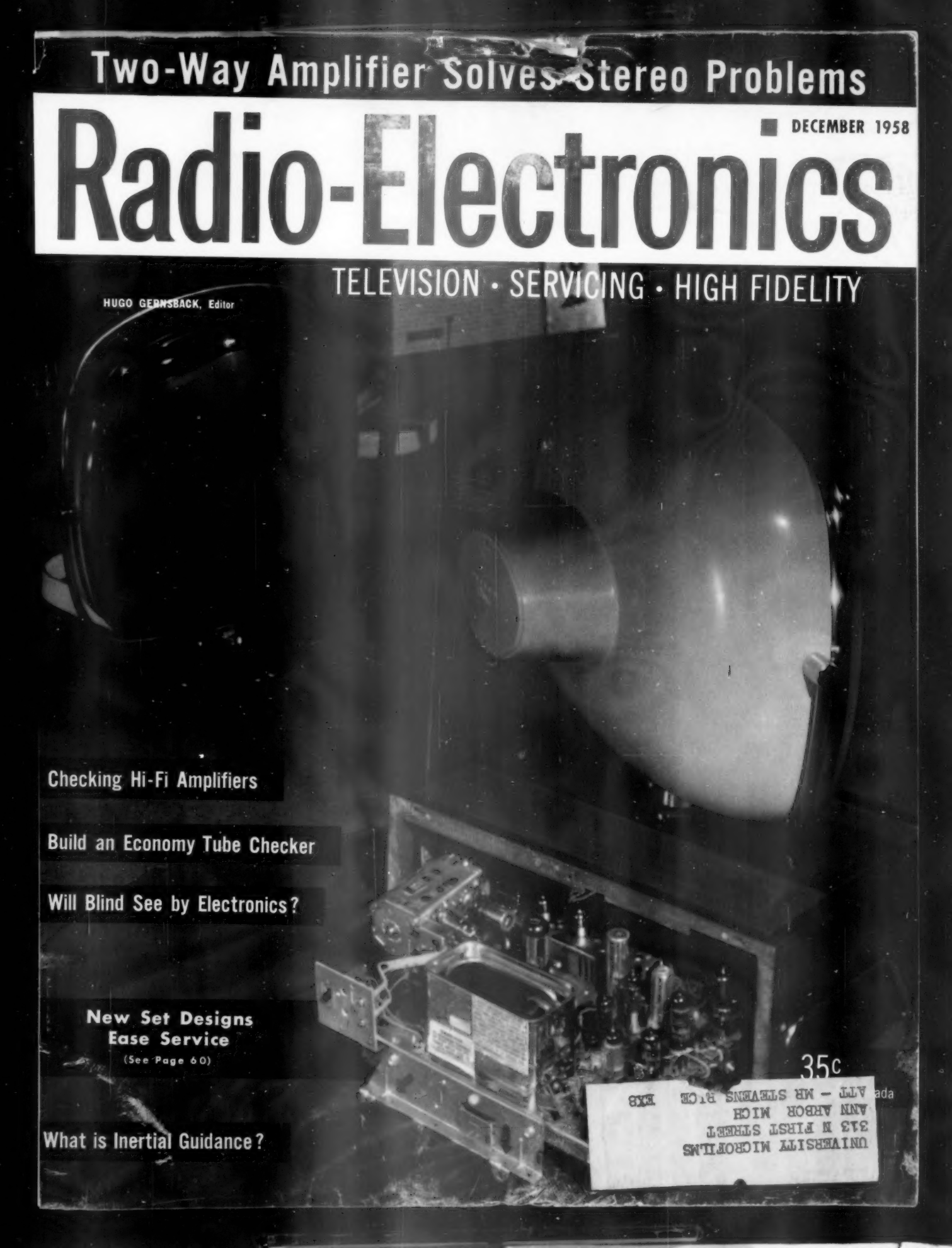
Two-Way Amplifier Solves Stereo Problems

Radio-Electronics

DECEMBER 1958

TELEVISION · SERVICING · HIGH FIDELITY

HUGO GERNSBACK, Editor



Checking Hi-Fi Amplifiers

Build an Economy Tube Checker

Will Blind See by Electronics?

New Set Designs Ease Service

(See Page 60)

What is Inertial Guidance?

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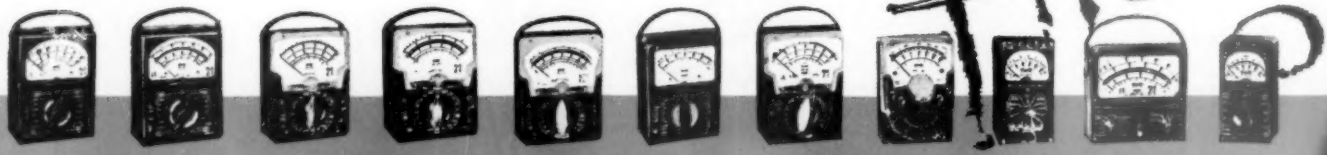

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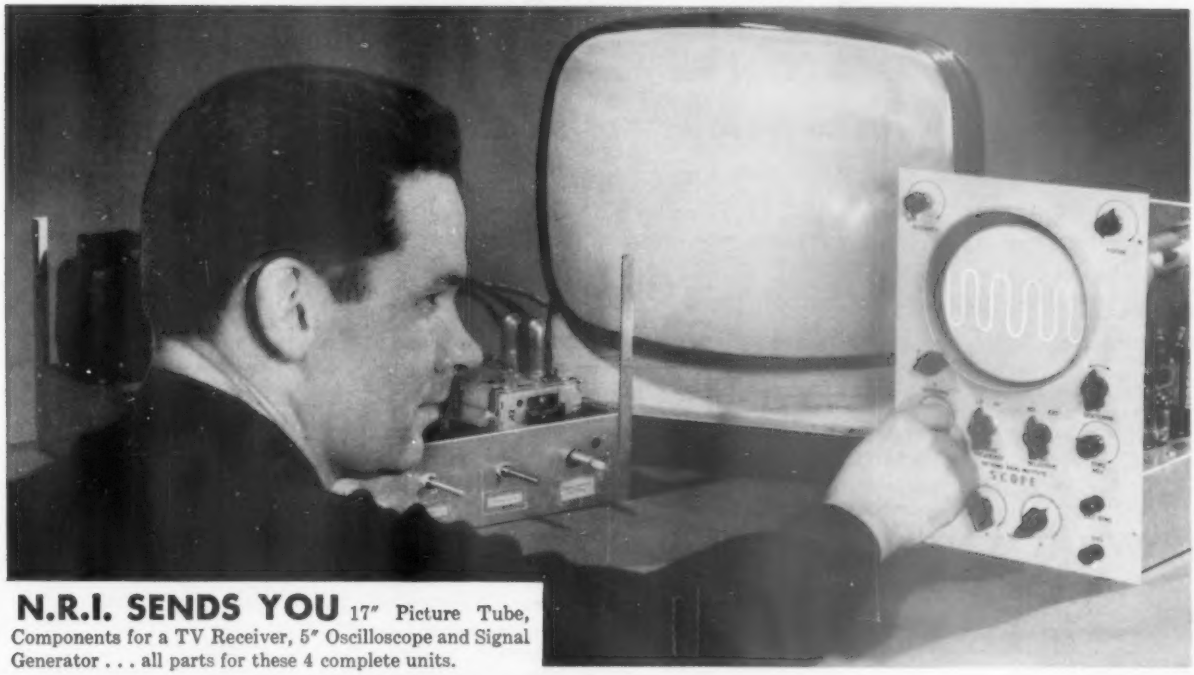

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ON THE COVER

(Story on page 60)

For easy servicing, chassis of the Philco Predicta TV slides out of cabinet on a track. At left is the Predicta Tandem's cable-connected viewing screen assembly, which can be placed up to 25 feet away from the main chassis.

Color original courtesy Philco Corp.

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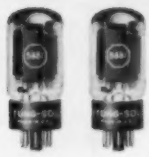

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HI-FI FM NETWORKS in the more populated areas may be a byproduct of the increasing public interest in good sound reproduction. New York's WQXR has leased a 15,000-cycle telephone line from Boston to New York for its weekly live broadcasts of the Boston Symphony Orchestra—the only intercity high-fidelity line now in use for radio broadcasting.

Radio networks traditionally use the much less expensive 5,000-cycle lines, adequate for AM but incapable of carrying the full band of frequencies which can be passed by FM.

WQXR now is the originating point for a network of 12 FM stations in upstate New York. These stations are linked, not by network lines, but by off-the-air pickup, being strategically located in a "chain" arrangement.

Maj. Edwin Armstrong had a leased 15,000-cycle line for networking high-fidelity FM broadcasts between his experimental W2XMN in Alpine, N. J., and Washington, D. C. A 15,000-cycle line is still in use between Washington and the New York area. It's leased by the US Information Agency for the Voice of America, and isn't used directly for broadcast purposes, but rather for making 15-ips tape recordings in Washington from live concert performances in New York for distribution to radio stations overseas by US embassies in foreign countries.

GENERATION OF ELECTRICITY in usable amounts directly from heat may be possible within the next 5 years as the result of the discovery of a new class of thermoelectric materials, according to Dr. Clarence Zener, director of Westinghouse Research Laboratories.

The new materials are ceramics (shown here in powder and pellet form) and are essentially nonconductors of electricity. While the thermoelectric effect has been noted in metals for many years, their maximum thermoelectric efficiency (about 1%), is far too low for power purposes. Semiconductors have relatively good efficiency, but not at the high temperatures at which power is usually generated.

Dr. Zener says the new ceramics, which are cheap and plentiful, offer promise of power generation at temperatures around 2,000–3,000°F at efficiencies which may reach 20–30%.

ATOMIC SUBMARINE Nautilus used a supersensitive closed-circuit TV system which could virtually "see" in the dark during its recent trip under the polar ice pack. Among the few details about the Nautilus' TV equipment which have been released are these:

The camera was mounted vertically in a pressurized 1-ton steel capsule in the sail (conning tower) of the ship, its lens aimed through a glass porthole. A cable was strung through two watertight seals into the periscope room, where a 21-inch monitor showed a clear picture of the ice overhead. No artificial light was required. The TV system was built by General Electric.

ELECTRONIC EARS have been built directly into deaf human beings, restoring their hearing, in the first reported cases of "artificial senses."

The first successful experiment with a human was carried out by Prof. Andre Djourno and his associates in the Faculty of Medicine, Paris, after tests on animals.

The first human installation was made last year on a patient who was totally deaf as a result of the removal of cysts from both ears. Using a binocular microscope, surgeons placed a tiny plastic-covered induction coil behind the temporal bone. The coil was an inch long, with fine silver wire wound on an iron core. One of the coil wires was connected to a tiny sliver of the auditory nerve which was found to be intact.

Three days after the operation, the

(*Continued on page* 10)

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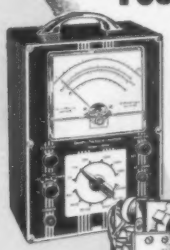

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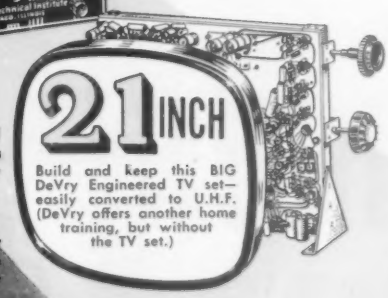

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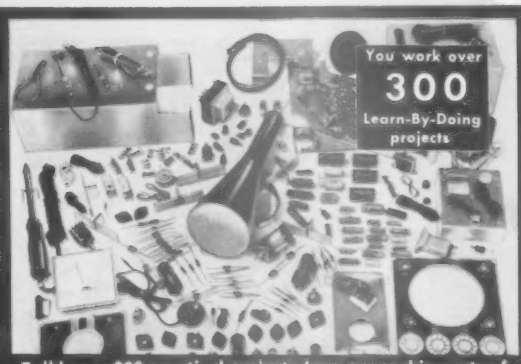

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Literature available: Department 12-L

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NEWS BRIEFS *(Continued from p. 6)*

patient's new hearing was tested. Words were spoken into a microphone connected to an amplifier and primary coil held close to the patient's skull. He was able to recognize a few simple words, although he said they were blurred by whistling sounds. After months of practice with a tape recorder, he is now able to understand about 75% of what is said to him, although what he hears is different from normal speech. He can also hear sounds above and below the normal hearing range.

Since the initial experiment, other patients have been operated on successfully. One prerequisite for a successful operation is that the auditory nerve of the inner ear be at least partially functional.

GOVERNMENT RESEARCH program on teleducation—use of television in education—and other audio-visual aids is expected to begin soon on a large scale. Almost unnoticed as the last session of Congress rushed to adjourn was the earmarking of $18,000,000 to the US Office of Education for this purpose. It was part of the $887,000,000 national defense education bill, whose primary objective is to encourage the study of science through loans to students.

A far bigger teleducation bill died with the Congress. Passed by the Senate but not by the House was a measure which would have provided a $1,000,000 Federal grant for educational TV equipment to every state and territory which puts up an equal amount for the same purpose. Sponsored by influential Senator Warren G. Magnuson (D–Wash.), it is certain to be reintroduced in the next Congress.

Calendar of Events

Electronic Computer Exhibition, Nov. 28–Dec. 4, Olympia, London, England.

EIA Conference on Reliable Electrical Connections, Dec. 2–4, Statler-Hilton Hotel, Dallas, Tex.

Eastern Joint Computer Conference, Dec. 3–5, Bellevue-Stratford Hotel, Philadelphia, Pa.

Second National Symposium on Global Communications, Dec. 3–5, Colonial Inn, St. Petersburg, Fla.

1958 Mid-America Electronics Convention, Dec. 9–11, Municipal Auditorium, Kansas City, Mo.

Hi-Fi Music Show, Jan 9–11, Dyckman Hotel, Minneapolis, Minn.

Symposium on Reliability and Quality Control, Jan. 12–14, Bellevue-Stratford Hotel, Philadelphia, Pa.

Hi-Fi Music Show, Jan. 30-Feb. 1, Hotel Antlers, Indianapolis, Ind.

MOON-PROBE rocket Pioneer gave scientists the first direct confirmation that the earth's magnetic field resembles that of a bar magnet, an analysis of preliminary data appeared to indicate.

Magnetic measuring equipment in the vehicle gave support to the theory that the effective range of the lines of force field extends to 20,000–25,000 miles from the earth. The fact that the radiation measured by Pioneer dropped to a small figure beyond 20,000 miles tends to confirm the theory that most of the radiation in space around the earth is

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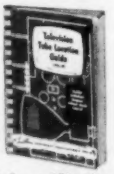

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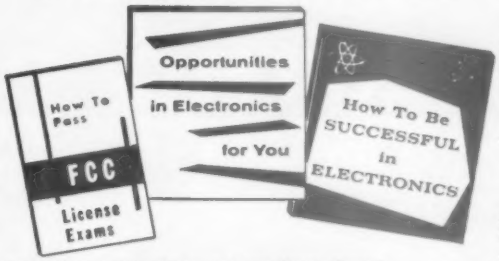

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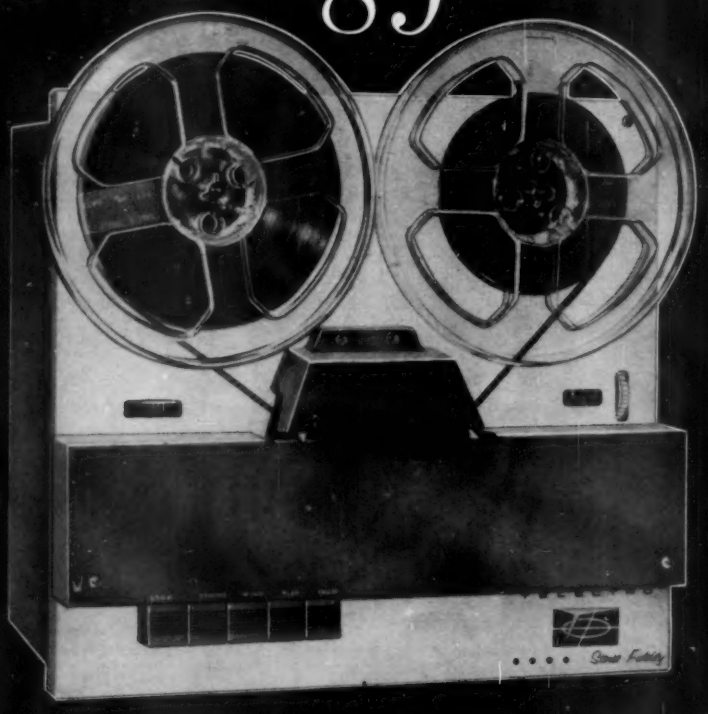

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There are five models to choose from including a three-head unit with provision for simultaneous monitoring while recording. (Matched Record/Play preamplifier with VU meter and a play preamplifier are available.)

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900-1	Monaural Record, Stereo Play
900-2	Monaural Record, Stereo Play, Monitor
900-3	Stereo Record, Stereo Play
900-4	Stereo Play
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FOR FURTHER INFORMATION WRITE

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the result of particles trapped in the magnetic field. (See photo, What's New, page 52.)

The space vehicle's signals were the most powerful ever received at Britain's Jodrell Bank radio telescope (described in RADIO-ELECTRONICS, February, 1958, page 32). Prof. A. C. B. Lovell, director of the telescope installation, said the information gained was "priceless." He reported 112 "fixes" of the rocket's position were received, as well as clear telemetered information on temperatures, meteorite impacts and ion content in space.

THREE NEW TV STATIONS are operating:

WJRT, Flint, Mich.....12
KCMT, Alexandria, Minn.....7
KTES, Nacogdoches, Tex.....19

The only station to quit was WHCT, Hartford, Conn., channel 18.

In Birmingham, Ala., channel 13's WABT changed its call letters to WAPI-TV.

These changes bring the roster of US operating stations up to 540, 453 vhf and 87 uhf. The total of noncommercial stations, 32, is unchanged.

TAKE A GOOD LOOK at that "live" TV commercial. If it's on a network show, chances are it's not live at all, but taped. This season, Videotape commercials are replacing live ones on most network programs. And within the next year, you'll begin to see taped TV shows replace filmed ones—but the process will be slow because most TV stations don't yet have Videotape recorders, although all networks do.

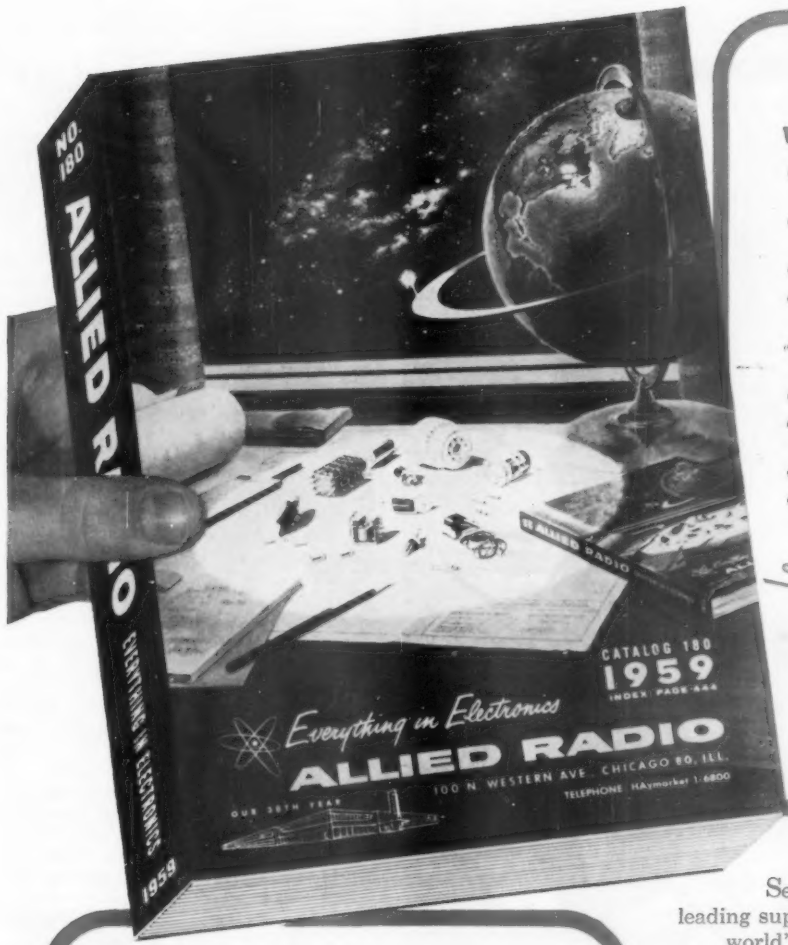
In the 2 years it has been producing Videotape recorders, Ampex Corp. has delivered nearly 200 of the $45,000 machines. Not all of them have gone to TV stations, either. Among the novel uses: Yonkers Raceway, in New York State, records all races on tape, which can be played back for the judges before the photo-finish still pictures can be developed. It has paid off at the betting windows, too. Race results are posted more quickly, and spectators have a longer time to place their bets on the next race.

AS 1958 ENDS, the number of television sets in use throughout the world totals more than 75,000,000, of which nearly two-thirds—about 49,000,000—are in the United States. Somewhat more than 5,000,000 new TV receivers were sold in the US during 1958, compared with more than 6,500,000 last year.

The year will close with more than 165,000,000 radios in use in this country, or the equivalent of one for nearly every man, woman and child. About 10,000,000 radio receivers were produced during the year. This is 5,000,000 less than last year.

About 100 new AM stations went on the air during the year, bringing the total close to 3,300. FM outlets showed an increase, too, 15 new ones beginning broadcasts for a total of more than 550—and 100 more which have been authorized by the FCC are expected to start in 1959.

free! ALLIED'S 1959 value-packed 452-page ELECTRONIC SUPPLY CATALOG



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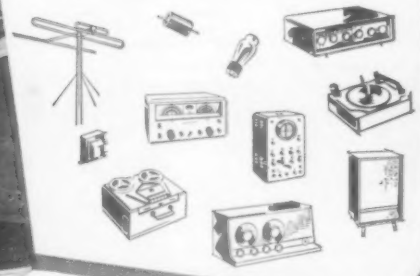

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NEWS BRIEFS *(Continued)*

RADIO-CONTROLLED lawnmowers are being designed by at least one manufacturer. The Western Tool & Stamping Co., Des Moines, revealed at the recent Hardware Show in New York that it is now working on a remote-controlled wireless mower, which can be operated from porch or hammock.

Other manufacturers say they have wire-controlled remote mowers in the works, with motor-driven steering gear and solenoid speed control, connected to a control box by 125 feet of cable.

TRANSOCEANIC TV will be both economically and scientifically feasible soon, through use of earth satellites as passive reflectors, according to Dr. John R. Pierce, Bell Telephone Laboratories director of electrical communications research.

He told an IRE symposium in Washington that the best site for the relay system would be over the Atlantic between Newfoundland and Scotland. He proposed a series of 100-pound satellites 100 feet in diameter, with reflective metallized coating, revolving in a transpolar orbit 3,000 miles in space.

The satellites need have no electronic equipment in them. The signals would be bounced off them from 250-foot parabolic antennas on the ground, fed by 100-kw transmitters. He suggested frequencies of 1,500–2,000 or 8,000–10,000 mc. A total of 24 such spheres would be sufficient for 99% continuity of contact, he added. He stressed the advantage of such passive reflectors: All of the electronic equipment is on the ground.

The first practical proof of the feasibility of satellite radio relay stations was demonstrated by moon-probe rocket Pioneer. CW signals in the 108-mc band were transmitted by the Air Force to the space vehicle, automatically repeated and picked up at tracking stations almost halfway around the world. Stations communicating via space relay were in Cape Canaveral, Fla.; Manchester, England, and Hawaii.

HURRICANE-BORNE radio transmitters are now helping the US Weather Bureau keep track of violent storms. The bureau and the Air Force have placed a balloon-borne radio beacon in the eye of a tropical storm which later developed into a hurricane.

The balloon, deflated, with a vhf transmitter in a 20-pound 11-inch cylinder was dropped from the bomb bay of a B-50 bomber into the storm's eye. The balloon automatically inflated to about 20 feet in diameter. The whirling winds kept the balloon in the eye of the storm, while coastal tracking stations followed the progress of the storm by means of the radio signals.

Each balloon-beacon is designed to float in the eye of a storm for as long as 24 hours at 4,000–15,000 feet. The eventual goal of the program is development of a telemetering system which can report other information about the storm, besides its position. END

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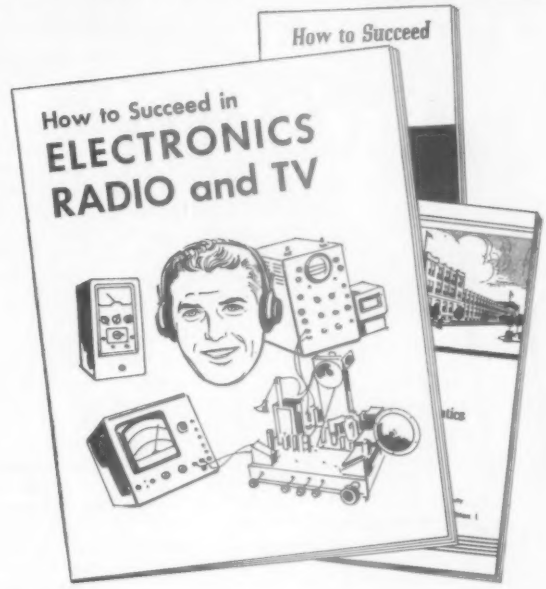
I.C.S. Career Kit tells you where the big-pay jobs are... who are the industry's most wanted men ...how you can "cash in" in a big way on your own future.



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So take a minute now to get a look at your future in Radio-TV-Electronics. Send for your free I. C. S. Career Kit. You have nothing to lose. You can gain an exciting, well-paid career in a vital industry.

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Correspondence

TECHNICIAN'S CHRISTMAS LIST

Dear Editor:

Seems like I got my letter out to Santa too late? I have already run into the '59 receivers—particularly the portable TV sets. Here's my list of requirements that would not impede progress and make a TV set easier to repair:

1. Outlaw printed circuits except for missile work where they are blown to bits anyway.
2. Don't separate controls or tuner from the main chassis.
3. Put a socket connection for the yoke on all chassis with a separate picture-tube mounting.
4. Get rid of series circuits. These are real time wasters.
5. Make selenium rectifiers plug-in types that can be replaced without pulling the chassis.
6. Use only snap-in diodes also replaceable without pulling chassis.
7. Put tubes and pilot lights where they can be gotten at without moving the chassis or running into the high-voltage supply.
8. End indiscriminate use of tube types. There are too many different types in use and each year sees new ones added to the list.
9. Mark all chassis with model and chassis number.

My other gripes would be directed at engineering since some of the '58 gems don't even let you make voltage checks without special adapters.

Each year has seen the manufacturer strangling the service technician with bad engineering by turning out a product which is increasingly unprofitable to service. ELMER WOODS

Los Angeles, Calif.

THERMOELECTRIC RADIO

Dear Editor:

Your picture of a kerosene lamp-energized thermoelectric generator (What's New?, RADIO-ELECTRONICS, October, 1958, page 52) looks almost like several I built in 1922 and still have.

Several hundred series-connected iron-constantan junctions were used, each element being 1 inch long, ⅜ inch wide and .01 inch thick. These were welded together at their ends, forming a zig-zag series, the iron and constantan strips alternating. Porcelain tubes with narrow longitudinal outside slots provided a mounting, the alternate welded couples being pressed and cemented into them, forming a spiral around this tube. Asbestos cord and cement enclosures of the inner junctions served as further heat insulation, leaving about a ½ inch of the outer junctions extending radially outward.

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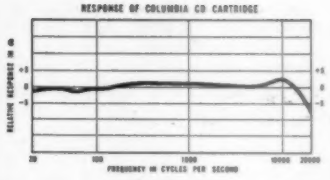

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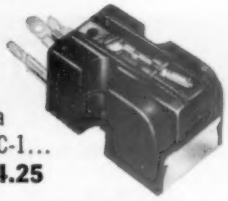

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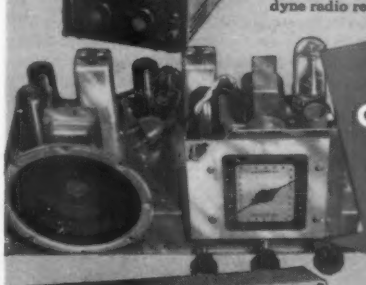

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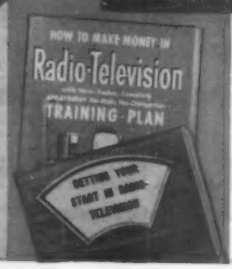

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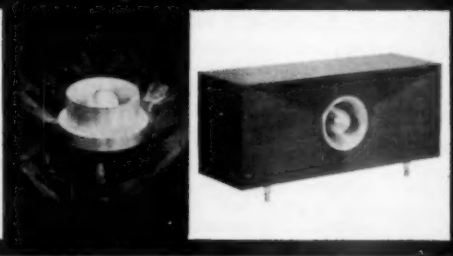
Now JBL enclosures are matched for stereo. If you own a JBL system such as the C34, C37, C39, or C40, you can get a matching enclosure with speaker units in an arrangement that is a mirror image of your present system.

The connoisseur of precision will be delighted with a JBL 075 High Frequency Unit. This gratifying example of the finest audio craftsmanship is also available with its own cabinet, Model C41, the Angelus.



The new JBL Ranger-Metregon will brighten many a hearthside this Christmas. This is the first system to use radial refraction in an enclosure of acceptable size for the average living room. Built on principles perfected in the fabulous JBL Ranger-Paragon, a curved refracting surface is used to integrate two sound sources and fill an extremely wide area with true stereo. No hole in the middle, no split soloists, but sound reproduction spatially proportional to its original source. It accepts seven different speaker system combinations; can be upgraded progressively.

Write for complete catalog, descriptive bulletins of the products in which you are particularly interested and the name of the Authorized JBL Audio Specialist in your community.

JAMES B. LANSING SOUND, INC.

3249 Casitas Avenue, Los Angeles 39, California

CORRESPONDENCE *(Continued)*

For some of these units I used gas or oil lamp heat, as shown in your photo of the device made by the Philips Research Laboratories, and as the Russians also are reportedly doing. For others, I used an internal coil of nichrome resistance wire for ac heating. These were intended for A-current supply for the earliest home radios.

They developed about 8 volts dc on open circuit and about 6 volts with a 6-ohm 1-ampere load, but the input power was about 500 watts! The output could be considerably increased by fan cooling. Outside dimensions were 6 inches long by 3–4 inches diameter.

Another form, utilizing punched, spoked-wheellike discs with central holes, was devised as more suitable for production. Insulating mica inner and outer rings and similar copper rings were used with the alternate iron and constantan discs to form a stacked coaxial series of junctions under pressure, the heat being applied inside the central axial hole. Air convection, circulation and radiation through the spaces between the aligned spokes, and from the outer ring, provided a good temperature difference between the outer and inner ring junctions—the radial spokes between them providing connections between the outer cool ones and the inner hot ones.

While such thermoelectric devices were not practical in the old, 201-A tube days, they may be with transistors.

In far outlying regions, without electric power or handy battery suppliers, oil-heated direct-current generators of this type can meet a real need. Here the oil lamp will supply illumination as well as heat for the thermogenerator.

Also, where much thermal power is thrown away—as in aircraft, automobiles, etc.— such devices can even now perform very useful service. Modern solid-state physics can no doubt also provide higher-efficiency junctions.

More attention should be given such devices as they just *might* be the answer for future electric power generation.

B. F. MIESSNER
Meissner Inventions, Inc.
Morristown, N. J.

FOREIGN TV DXING

Dear Editor:

Hartland B. Smith's "Looking In on London" (RADIO-ELECTRONICS, September 1958, page 52) is excellent but I feel a few additions would be valuable.

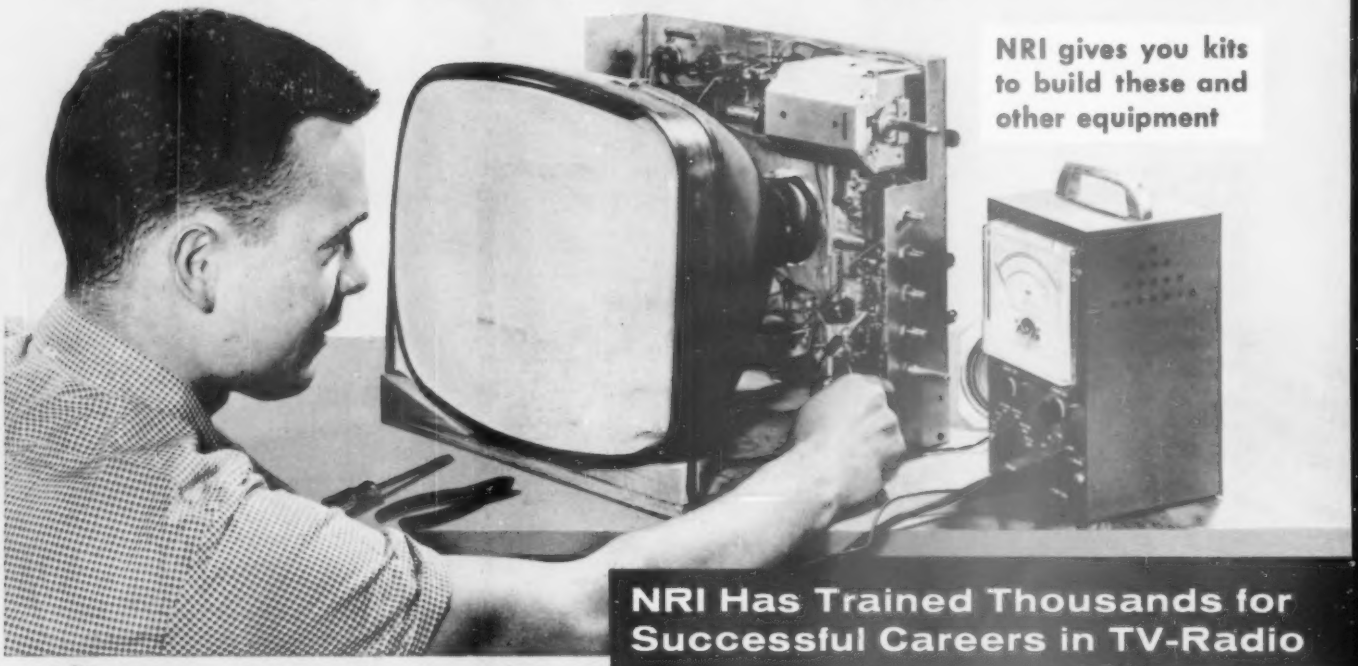
First, the photo of the BBC test pattern was printed upside-down.

TV dxing is indeed an avocation for the beginner, but conversion of the TV set may have to be done with the help of a technician. Except for Britain, European TV stations operate with standards so close to ours that little, if any, modification is required to receive them. European channel 3 is on the same frequency as our channel 2 except that the sound is 1 mc higher (60.75 mc). And if you add a converter to make your TV tune to 48.25 mc,

Learn TELEVISION-RADIO

Servicing or Communications

by Practicing at Home in Spare Time



NRI gives you kits to build these and other equipment

Electronic Technicians Have High Pay, Prestige Jobs

People look up to and depend on the Technician, more than ever before. His opportunities are great, and are increasing. Become a Radio-Television-Electronic Technician. At home, and in your spare time, you can learn to do this interesting, satisfying work—qualify for important pay. A stream of new Electronics products is increasing the job and promotion opportunities for Television-Radio-Electronic Technicians. Right now, a solid, proven field of opportunity for good pay is servicing the millions of Television and Radio sets now in use. The hundreds of Television and Radio stations on the air offer interesting jobs for Operators and Technicians. The military services reward qualified Technicians with higher rank and pay. Police, Aviation, Mobile Two-Way Radio are expanding. To ambitious men everywhere: here is rich promise of fascinating jobs, satisfaction and prestige, increasing personal prosperity.

Make Extra Money Soon, $10 to $15 a Week in Your Spare Time

NRI students find it practical and profitable to start fixing sets for friends and neighbors a few months after enrolling. Picking up $10, $15 and more a week gives substantial extra spending money. Use the Tester built with parts NRI furnishes, to locate and correct Radio-TV receiver troubles. Many who start in spare time, soon build full time Television-Radio sales and service businesses; others enjoy profitable spare time businesses and the security of a source of income to fall back on in case of layoffs, hard times or other changes in regular job. Postage free card will bring you complete facts about the NRI tested way to better pay.

ACT NOW FIND OUT WHAT NRI OFFERS YOU

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"I am now Studio Engineer at Television Station KATV. Before enrolling for the NRI Course, I was held back by limitation of a sixth grade education." BILLY SANCHEZ, Pine Bluff, Ark.

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"Since finishing NRI Course I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Ga.

Has Good Part Time Business
"Quite early in my training I started servicing sets. Now have completely equipped shop. My NRI training is the backbone of my progress." E. A. BREDA, Tacoma, Wash.

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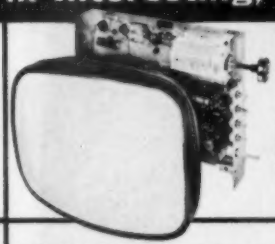
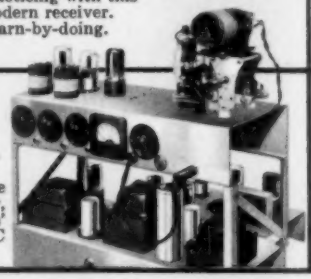
YOU BUILD AC-DC Superhet Receiver

NRI Servicing Course includes all needed parts. By introducing defects you get actual servicing experience practicing with this modern receiver. Learn-by-doing.



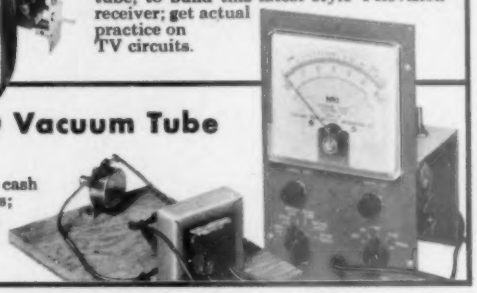
YOU BUILD This 17 Inch Television Receiver

As part of your NRI course you can get all components, tubes, including 17" picture tube, to build this latest style Television receiver; get actual practice on TV circuits.



YOU BUILD Broadcasting Transmitter

As part of NRI Communications Course you build this low power Transmitter, learn commercial broadcasting operators' methods, procedures. Train for your FCC Commercial Operator's License.



YOU BUILD Vacuum Tube Voltmeter

Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

For Higher Pay, Better Jobs Be a TV-Radio-Electronic Technician

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Portable TV, Hi-Fi, Transistor Radios, Color TV are making new demands for trained Technicians. Good opportunities for spare time earnings or a business of your own.

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J. E. Smith, Founder

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NRI Course Easy to Understand
"I opened my own shop before receiving my diploma. I have had to hire extra help. I am independent in my own business." D. P. CRESSEY, Stockton, Cal.

Works on Color-TV
"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA - TV." J. F. MELINE, New York, N.Y.

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SEE OTHER SIDE

there's a better chance of receiving European dx, as this is their channel 2.

Speaking of converters, Mr. Smith's unit might be difficult to tune. Modification of a continuous tuning device is more satisfactory, as a separate tuner isn't required to hear the sound. Also, some old TV's (pre-1948) have continuous tuners which include the old US channel 1. These are easily made to tune the whole TV band in use.

The simplest antenna is a vertical dipole cut to the desired frequency. There is no problem of directivity and the radiation angle is more suited to this type of dx. GORDON E. SIMKIN
International Dx Editor
Amer. Ionospheric Propagation Assoc.
Loma Linda, Calif.

NO GRAVY TRAIN

Dear Editor:

Where are YOUR ethics?

RADIO-ELECTRONICS has been converted to a garbage collection agency and has joined the ranks of the scandal rags who must slander the independent TV service industry and other minorities, in order to sell their trash!

E. H. Leftwich's article in the November issue, "The TV Man Rides the Gravy Train," (page 98) is an affront to many of your readers. It is malicious and the figures you quote are not realistic.

Take for instance the daily parts sales, which are iisted as $300. Using an average for the net of 40% off, net parts expenditures per day would average $180. Even in a well-run shop, there will be losses, such as breakage, obsolete stock and plain forgetfulness in filling out bills. Adding these losses would bring the net closer to $200. Yearly this would amount to about $60,000. Yet you enter the annual outlay for parts as only $13,500. Any third-grader can see that boner at once. No expense is entered for the telephone service, which for a store with 15 employees will amount to quite a yearly figure, certainly too large to be included in the $900 you list for utilities. Accusing two California accountants of such oversights is close to slander.

RADIO-ELECTRONICS could better serve the needs of its subscribers by publishing facts instead of fiction. Articles on sound business management for TV service shops, written by authorities in the field would be a better choice than the clumsy home-brew of some disgruntled stranger to our problems.

Springfield, Ohio PAUL BOLLER

(Mr. Leftwich is not exactly a "stranger to our problems," but a veteran of the radio service field and author of the article "The Customer Will Gyp You if You Don't Watch Out," written in answer to the historical *Readers Digest* "expose." And there are outfits like Trustworthy TV—a technician would have to be quite innocent to believe these practices do not exist. A copy of the letter has been forwarded to Mr. Leftwich for comment on the points raised.—*Editor)* END

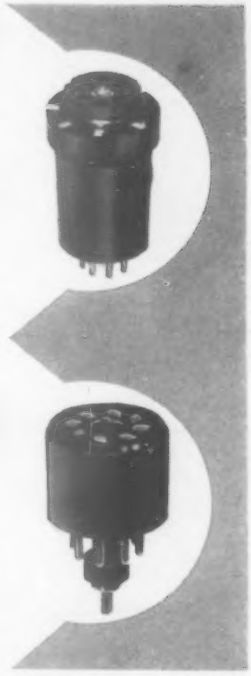
Save Time and Effort with these handy

Walsco TUBE SERVICING AIDS

WALSCO TEST SOCKET ADAPTERS

Now you can make measurements of voltage, resistance, audio and video from the top of the chassis. Save time and work by testing tube circuits while in full operation. Made of low-loss phenolic, these tube socket adapters have an insulation resistance of 500,000 megohms (40% RH-24° C). High voltage breakdown between elements exceeds 1700 volts AC-DC. Test tabs on adapters are extended for easy use with prods or alligator clips.

Cat. No.	Description	Dealer Net
1949-07	7-pin miniature	$1.65
1949-08	8-pin octal	1.55
1949-09	9-pin miniature	1.85
1949-01	Duo-Decal for CRT	1.95



WALSCO SOCKET PROTECTORS

Prevent excess wear and tear of sockets on tube checkers and other electronic equipment. Walsco socket protectors eliminate the necessity of checking and replacing original sockets. Time-saving and easy to use. With silver-plated phosphor bronze contacts and pins for lasting service.

Cat. No.	Description	Dealer Net
1946	7-Pin Miniature	$1.95
1947	8-Pin Octal	1.95
1948	9-Pin Miniature	1.95

110° BASE ADAPTERS

Convert 110° CRT type base to Duo-Decal base for rejuvenators, test equipment, tube checkers, etc.

Cat. No. 1944 (RCA)
Dealer Net $1.50
Cat. No. 1945 (Sylvania)
Dealer Net $1.50

110° TUBE PIN STRAIGHTENER

For RCA type 110° picture tubes. They straighten bent pins quickly and easily. May also be used as base protector. A handy time-saving piece of equipment.

Cat. No. 1941
Dealer Net $ .51

NEW WALSCO TUBE GUIDE

Eliminates fumbling when inserting 9 and 7 pin tubes. Center pin of tube guide aligns tube with center hole of socket and guides tube in easily and quickly.

Cat. No. 1942 (7 pin)
Dealer Net $ .42
Cat. No. 1943 (9 pin)
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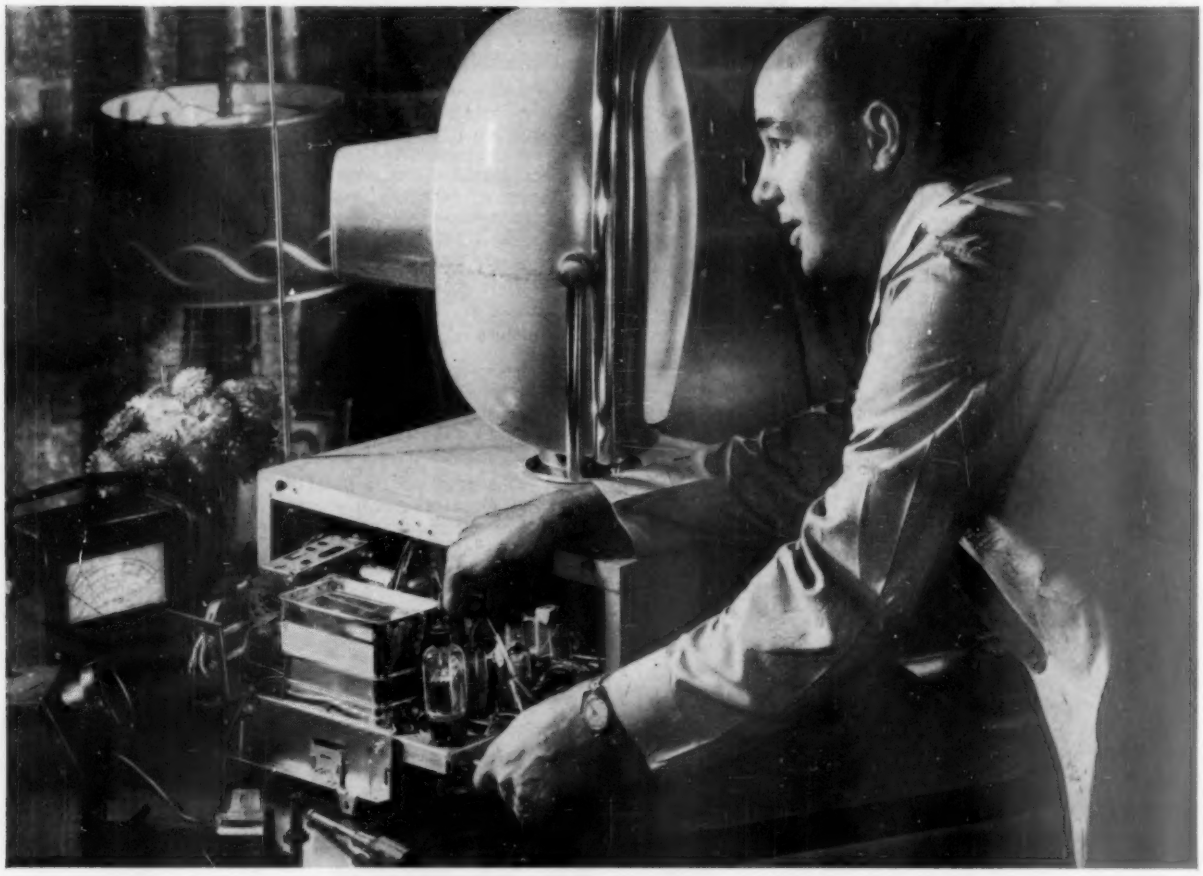
saves time, trouble and temper!



Chassis slides out like a drawer...tube swivels, lets you check picture while you work...without mirrors!

Here's a new TV chassis that's right down your alley – so totally different it's *easier*, more *profitable* to service than any chassis ever designed!

After you remove the screws from the back of the cabinet, the Predicta chassis slides out on runners, and provides instant access to every component. And Philco's exclusive new separate-tube design makes it possible to service the chassis *while the set is operating*. Now, typical service jobs like changing condensers take 50% less time and effort!

That's not all, Philco's swivel screen eliminates back-breaking contortions and dangling mirrors. With Predicta you can see the picture and check the results of your work as you do it. Yes, this is the chassis it *pays you* to service ... just one of the many reasons why most dealers are selling Philco Predicta, truly TV today from the world of tomorrow!

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"I find I can save 50% of my time by using PHOTOFACT for everything—alignment, replacement parts, schematics, etc. In fact, if anything happened to my PHOTOFACT and I couldn't replace them, I think I'd just close my shop."
—Charles F. Burket
Elkhart, Kansas

CALIFORNIA
"We use PHOTOFACT daily. I don't believe we could conduct a first-class service shop without them. They are a time saver. With them, you can get to the base of your troubles in a hurry."
—P. W. Earls
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—Dwight L. Benson
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TEXAS
"Sams PHOTOFACT is the easiest and fastest method I have found..."
—Leroy Holloman
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IOWA
"I would find it impossible to give consistently reliable service without a complete PHOTOFACT file of service information."
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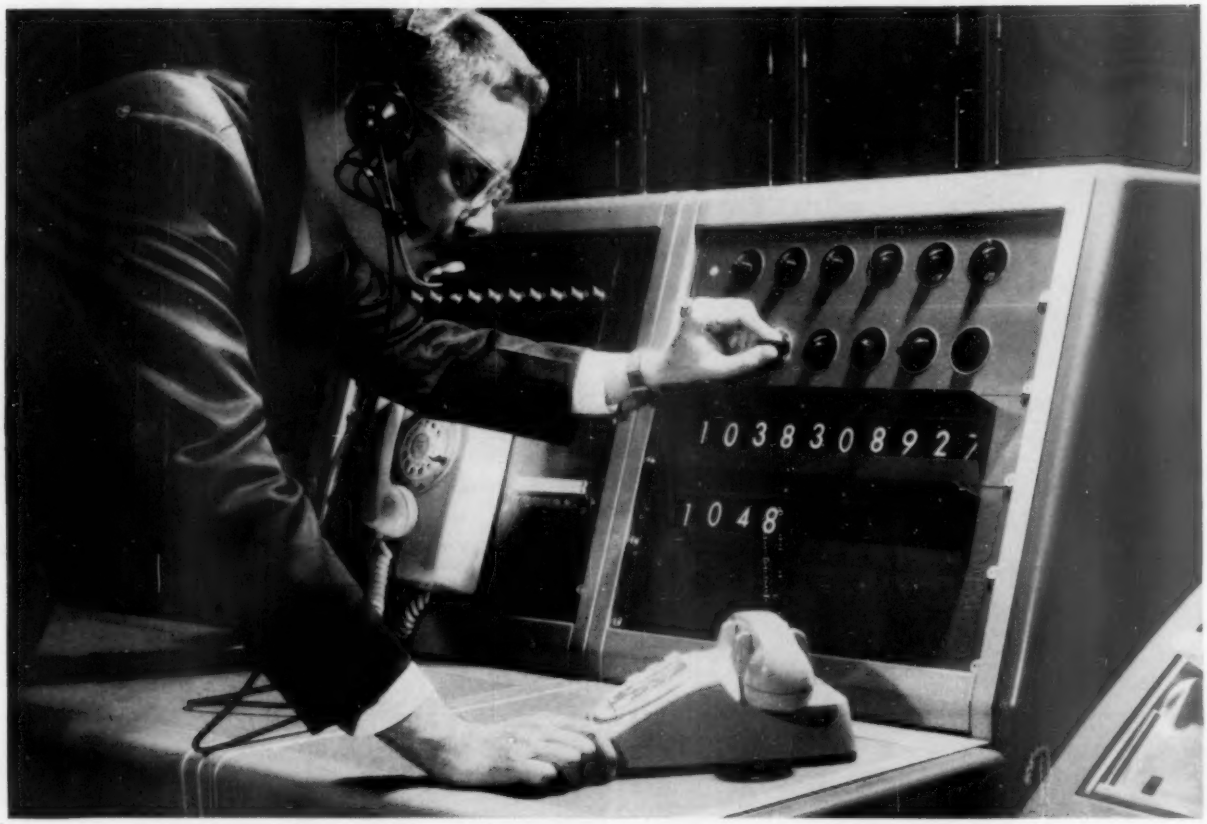
MECHANIZED ORACLE EXPLORES BELL SYSTEM COMMUNICATIONS



At monitoring console, designer H. D. Irvin watches performance of "Sibyl" during test of user-reaction to experimental telephones. A computer-like machine, Sibyl simulates the functions of future communications devices and records interplay between phones and users. Sibyl is named after the women oracles of ancient Greece.

A mechanized "oracle" is helping Bell Telephone Laboratories predict the future in communications devices and systems.

The oracle is "Sibyl," a computer-like machine developed by Bell Laboratories engineers and psychologists. It can simulate the action of many kinds of communications devices. Through Sibyl, new kinds of telephone service can be evaluated without the considerable expense of building actual equipment. Observing and recording users' reactions to the simulated equipment, Sibyl provides indications of how users would react to proposed new systems features and equipment.

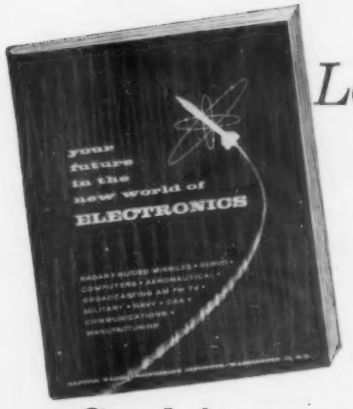
Sibyl, for example, is used to test the reaction of Bell Laboratories people to experimental push-button telephones. Each test subject has a push-button telephone in his office and he uses it in the ordinary course of his business. But the set is not connected directly to the local PBX: it is connected *through* Sibyl, which performs the special signaling functions required by such a push-button telephone. In this way, push-button telephone service is given to a group of people without modifying the PBX, or providing completely instrumented push-button telephones.

At the same time, Sibyl gathers information on how the call was placed—date, time, originator, speed of operation, errors, whether the line was busy or the call completed. Sibyl does all this without violating the privacy of telephone conversations.

Bell engineers expect that Sibyl will provide a better understanding of the relationship between telephone equipment and the people who use it. Sibyl's rapid and economical technique for evaluating new types of telephone sets is an important contribution to the art of telephony.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



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This is a brand new edition of the book which has launched thousands of men on good-paying careers in radio-TV-electronics.

It brings you completely up to date—answers important questions on newest career developments in electronics, including Radar, Guided Missiles, Servomechanisms, Computers, as well as Aeronautical Electronics, Broadcasting (AM, FM, TV), Military, Navy and CAA Electronics, Communications and Electronics Manufacturing.

This book, "Your Future in the New World of Electronics," also shows you how CREI Home Study leads the way to greater earnings in the booming electronics world.

However, CREI does not promise you a "snap." With accredited technical school curricula such as CREI offers, you must study to convert your ambition into technical knowledge which you can sell in the fabulous field of Electronics. Since its founding in 1927, CREI has provided thousands of professional electronics men with technical education. During World War II, CREI trained thousands for the Armed Services. Leading firms recommend CREI training for their own personnel. Among them: United Air Lines, Canadian Broadcasting Corporation, Trans-Canada Airlines, Douglas Aircraft Co., The Martin Co., Columbia Broadcasting System, All-American Cables and Radio, Inc., Gates Radio Co., Canadair, Ltd., Federal Electric Corp., and U.S. Information Agency (Voice of America).

CREI courses are prepared by recognized experts, in a practical, easily understood manner, and constantly revised to meet the new electronic challenges of our time. You get the benefit of time-tested study assignments under the personal supervision of a CREI staff instructor. Your studies are accomplished on your own time, during hours selected by you, and controlled by your own willpower. This complete training is the reason that graduates find their CREI diplomas keys-to-success in even the most advanced of electronic applications. CREI alumni hold top positions in America's leading firms. At your service is the CREI Placement Bureau, which maintains constant contact with electronic industry, and cooperates with employers and graduates in making satisfactory placements. This free service is available to students, as well as graduates. Fill out the coupon below *completely* and mail it now. We'll promptly send you your free copy of "Your Future in the New World of Electronics." The rest—you future—is up to you!

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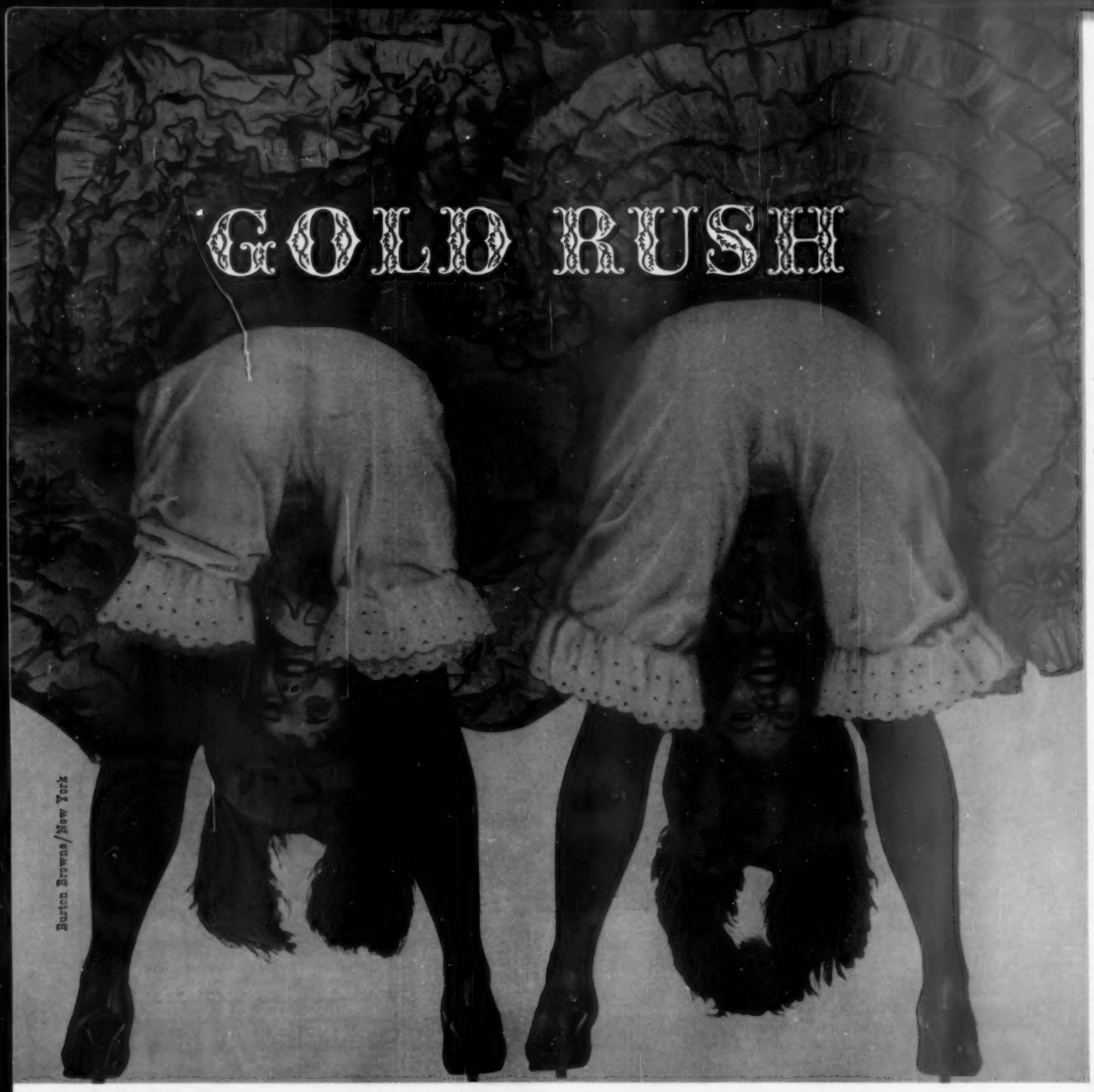
Electronics Experience.....



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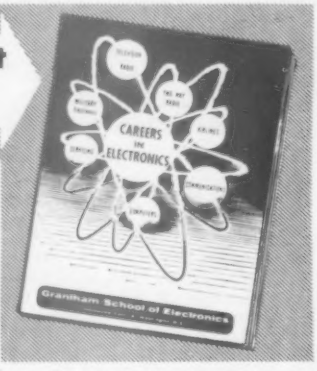

This free booklet gives details of our training and explains what an F.C.C. license can do for your future. Send for your copy today.

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	License	Weeks
Henry M. Best, 1003 Vermont St., Fremont, N.C.	1st	11
Harold V. Jones, P.O. Box 705, Alamogordo, N. Mex.	1st	13
Michael F. Aperio, 916 Townsend St., Chester, Pa.	1st	12
Norman R. Cook, 130 Olive St., Neodeska, Kan.	1st	12
Antone Mello, 68 Union Street, Nantucket, Mass.	1st	10
John Ward, 407 E. Cowden Ave., Midland, Texas	1st	10
F. T. Verga, 538 - 7th Street, Buffalo, N.Y.	1st	12
Philip J. Hooks, 4825 N. Capitol, N.W., Washington, D.C.	1st	12
Anthony Giaquinta, 404 Dale Dr., Silver Springs, Md.	1st	12
J. Milton Condit, 1312 N. 78th Street, Seattle, Wash.	1st	8
James W. Reichard, 707 Arlington Street, Tamaqua, Pa.	1st	8
G. Carl Patschke, 3220 Conn. Ave., NW, Washington, D.C.	1st	12

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a NEW stereo speaker system that combines...

- Unprecedented compactness - only 30"wide, 25"high, 12½"deep
- A third dimension to stereo sound ... DEPTH
- Placement **anywhere** in a room
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"Now, I must tell you, I have heard a speaker system that approaches the authenticity of concert hall performance."

MISCHA ELMAN

Now celebrating the 50th anniversary of his American debut, acclaimed throughout the world for his supreme virtuosity... internationally celebrated violinist Mischa Elman is an artist whose preference for concert hall performance over recorded music is a matter of public record. His enthusiasm after hearing the TMS-2 in his home is shared by many other leading artists, musical authorities and audio experts who also subjected the TMS-2 to critical listening tests under at-home conditions.

PATENT APPLIED FOR

The TMS-2 with deflector doors opened for full stereo reproduction.

Here the TMS-2 is shown with deflector doors closed for monophonic use.

University's NEW 'trimensional' stereo speaker TMS-2

Here is the most significant loudspeaker achievement since the advent of popular stereo ... a University development which, at last, actually eliminates *all* the problems of placement, space limitations, decor and cost ... but most important of all, produces a new kind of stereo sound ... the authenticity of concert hall *depth*.

COMPACT By utilizing the exclusive *dual voice coil* feature of the C-12HC woofer, only one bass enclosure and woofer are required to handle the entire low frequency range of both stereo channels. Extended, undistorted bass is superbly reproduced by making use of the RRL enclosure design so successfully employed in University's Ultra Linear Response systems. *See fig. 1.*

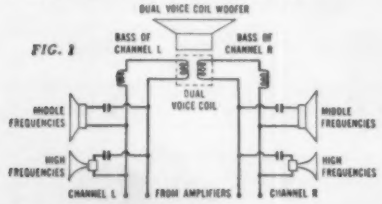

FIG. 1

REALISTIC STEREO The breadth, depth and clarity of stereophonic sound is accomplished by utilizing the walls of a room, just as the symphony orchestra uses the acoustical properties of the concert hall. The woofer sound emanates at the rear of the enclosure; one mid-range and one high frequency speaker for each channel project sound from each side of the cabinet. By thus deflecting all frequencies, in proper relationship, to the rear and side walls of the room, multiple stereo sound sources are created that not only provide the otherwise missing dimension of depth, but also preserve the stereo effect virtually throughout the room. *See fig. 2.*

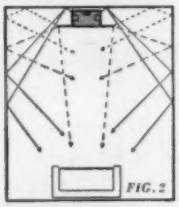

FIG. 2

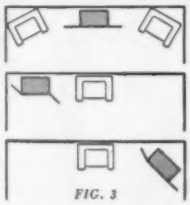

FIG. 3

USE ANYWHERE The unique design of the TMS-2 provides you with two distinct advantages: place it in a corner or *anywhere* along a wall, by merely positioning the deflectors as shown in fig. 3, and since there are *no particularly critical listening positions*, you, your family, your friends—any number of listeners—can enjoy the TMS-2 from most anywhere in the room.

MONOPHONIC OR STEREOPHONIC With deflectors closed, the TMS-2 is an outstanding, wide-range monophonic speaker system. "Presence" and "brilliance" controls are provided for both sets of mid and high frequency speakers. In addition to being used for balancing the system to room acoustics and personal taste, these controls and the deflectors may be adjusted to produce a pseudo-stereo effect with monophonic program material as well. Whether you start your high fidelity system with monophonic equipment, or go right into stereo, the TMS-2 is the best investment you can make... it is equally "at home" with any kind of program material, and *no further additions* to the speaker system are ever required.

DESIGNED RIGHT - PRICED RIGHT Flawlessly designed along simple, classical lines, beautifully proportioned to compliment the most exacting taste, the TMS-2 will enhance any decor. In fact, it looks more like a piece of fine furniture than a typical speaker cabinet. Breathtaking in its performance ... beyond the scope of conventional monophonic or stereophonic reproduction, the engineering concept of the TMS-2 eliminates redundant components; makes use of the latest, most advanced acoustic principles. RESULT: the ultimate in uncompromised value. *In Mahogany —$258, Blonde or Walnut—$263, User Net.*

See and hear the TMS-2 at your dealer ... NOW! You too, will agree with musical and audio experts that it marks one of the most extraordinary advances in high fidelity and stereo history!

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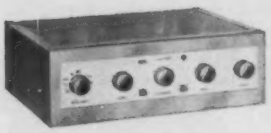
Stereo Preamplifier HF85

FM Tuner HFT90

Stereo Amplifier-Preamp HF81

Bookshelf Speaker System HFS1

Speaker System HFS2
36" H x 15¼" W x 11½" D



Monaural Integrated Amplifiers: 50, 30, 20, and 12-Watt (use 2 for Stereo)

Monaural Preamplifiers: HF65, HF61 (stack 2 for Stereo)

Monaural Power Amplifiers: 60, 50, 35, 30, 22 and 14-Watt (use 2 for Stereo)

Over 1 MILLION EICO instruments in use throughout the world.

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HF85: Stereo Dual Preamplifer is a complete stereo control system in "low silhouette" design adaptable to any type of installation. Selects, preamplifies, controls any stereo source—tape, discs, broadcasts. Superb variable crossover, feedback tone controls driven by feedback amplifier pairs in each channel. Distortion borders on unmeasurable even at high output levels. Separate lo-level input in each channel for mag. phono, tape head, mike. Separate hi-level inputs for AM & FM tuners & FM Multiplex. One each auxiliary A & B input in each channel. Independent level, bass & treble controls in each channel may be operated together with built-in clutch. Switched-in loudness compensator. Function Selector permits hearing each stereo channel individually, and reversing them; also use of unit for stereo or monophonic play. Full-wave rectifier tube power supply. 5-12AX7/ECC83, 1-6X4. Works with any 2 high-quality power amplifiers such as EICO, HF14, HF22, HF30, HF35, HF50, HF60. Kit **$39.95.** Wired **$64.95.** Includes cover.

HF81: Stereo Dual Amplifier-Preamplifier selects, amplifies & controls any stereo source—tape, discs, broadcasts—& feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Monophonically: 28 watts for your speakers; complete stereo preamp. Ganged level controls, separate focus (balance) control, independent full-range bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers, excellent output transformers. "Service Selector" switch permits one preamp-control section to drive the internal power amplifiers while other preamp-control section is left free to drive your existing external amplifier. Kit **$69.95.** Wired **$109.95.** Incl. cover.

MONAURAL PREAMPLIFIERS (stack 2 for Stereo)

NEW HF65: superb new design, inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit **$29.95,** Wired **$44.95. HF65** (with power supply) Kit **$33.95.** Wired **$49.95.**

HF61: "Rivals the most expensive preamps" — Marshall, AUDIOCRAFT. **HF61A** Kit **$24.95,** Wired **$37.95, HF61** (with power supply) Kit **$29.95.** Wired **$44.95.**

MONAURAL POWER AMPLIFIERS (use 2 for STEREO)

HF60: 60-Watt Ultra Linear Power Amplifier with Acro TO-330 Output Xfmr.; **"One of the best-performing amplifiers extant; an excellent buy."** AUDIOCRAFT Kit Report. Kit **$72.95.** Wired **$99.95.** Cover E-2 $4.50.

HF50: 50-Watt Ultra Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer. Identical in every other respect to HF60, same specs at 50W. Kit **$57.95.** Wired **$87.95.** Cover E-2 $4.50.

NEW HF35: 35-Watt Ultra-Linear Power Amplifier. Kit **$47.95.** Wired **$72.95.** Cover E-2 $4.50.

HF30: 30-Watt Power Amplifier. Kit **$39.95.** Wired **$62.95.** Cover E-3 $3.95.

NEW HF22: 22-Watt Power Amplifier. Kit **$38.95.** Wired **$61.95.** Cover E-2 $4.50.

NEW HF14: 14-Watt Power Amplifier. Kit **$23.50.** Wired **$41.50.** Cover E-6 $4.50.

MONAURAL INTEGRATED AMPLIFIERS (use 2 for STEREO)

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HF32: 30-Watt Integrated Amplifier. Kit **$57.95.** Wired **$89.95.** Both include cover.

HF20: 20-Watt Integrated Amplifier. "Well-engineered" — Stocklin, RADIO TV NEWS. Kit **$49.95.** Wired **$79.95.** Cover E-1 $4.50.

HF12: 12-Watt Integrated Amplifier. "Packs a wallop"—POP. ELECTRONICS. Kit $34.95. Wired **$57.95.**

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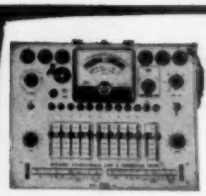

NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. **Tests all receiving tubes** (and picture tubes with adapter). **Composite indication of** Gm, Gp & peak emission. **Simultaneous sel** of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). **New series-string voltages:** for 600, 450, 300 ma types. **Sensitive** 200 ua meter. **5 ranges meter sensitivity** (1% shunts & 5% pot). **10 SIX-position lever switches:** freepoint connection of each tube pin. **10 pushbuttons: rapid** insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. **Direct-reading** of inter-element leakage **in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors:** separate meter readings of **collector leakage current & Beta** using internal dc power supply. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet. **CRA Adapter $4.50**

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• Features DC Amplifiers!

Flat from DC-4.5 mc, usable to 10 mc. **VERT. AMPL.:** sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull **thruout;** K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. **SWEEP:** perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); **preset TV V & H positions;** auto. sync. ampl. & lim. **PLUS:** direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

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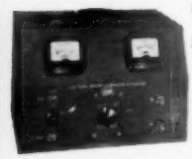
- illuminated roll-chart

Pix Tube Test Adapter **$4.50**



6V & 12V BATTERY ELIMINATOR & CHARGER #1050

KIT $29.95
WIRED $38.95

Extra-filtered for transistor equipt. #1060 KIT $38.95 WIRED $47.95

New! Miniaturized **MULTI-SIGNAL TRACER #145A**

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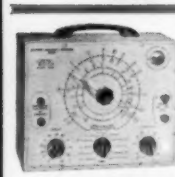

Reads 0.5 ohms —500 megs, 10 mmfd—5000 mfd, power factor.

KIT $19.95
Wired $29.95

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NEW! RF SIGNAL GENERATOR #324

KIT $26.95 WIRED $39.95

150 kc to 435 mc with ONE generator! Better value than generators selling at 2 or 3 times its cost! Ideal for IF-RF alignment, signal tracing & trouble-shooting of TV, FM, AM sets; marker gen.; 400 cps audio testing; lab. work. **6 fund. ranges: 150-400 kc, 400-1200 kc, 1.2-3.5 mc, 3.5-11 mc, 11-37 mc, 37-145 mc; 1 harmonic band 111-435 mc. Freq. accurate to ±1.5%;** 6:1 vernier tuning & excellent spread at most important alignment freqs. **Etched tuning dial,** plexiglass windows, **edge-lit hairlines.** Colpitts RF osc. **directly plate-modulated by K-follower for** improved mod. **Variable depth of int. mod. 0-50%** by 400 cps Colpitts osc. **Variable gain ext. amplifier:** only 3.0 v needed for 30% mod. **Turret-mounted coils slug-tuned** for max. accuracy. Fine & Coarse (3-step) RF attenuators. RF output 100,000 uv; AF sine wave output to 10 v. 50-ohm output Z. 5-way jack-top binding posts for AF in/out; coaxial connector & shielded cable for RF out. 12AU7, 12AV7, selenium rectifier; xmfr-operated. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

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Half-turn of probe tip selects DC or AC-Ohms.

Uni-Probe — exclusive with EICO — only 1 probe performs all functions!

Latest circuitry, high sensitivity & precision, wide **ranges & versatility. Calibration without removing from cabinet.** New balanced bridge circuit. High Z input for negligible loading. 4½" meter, can't burn-out circuit. **7 non-skip ranges on every function.** 4 functions: +DC Volts, −DC Volts, AC Volts, Ohms. Uniform 3 to 1 scale ratio for extreme wide-range accuracy. **Zero center.** One zero-adj. for all functions & ranges. **1% precision** ceramic multiplier resistors. Measure **directly** peak-to-peak voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v with HVP probe & 250 mc with PRF probe). Ohms: 0.2 ohms to **1000 megs.** 12AU7, 6AL5, selenium rectifier; xfmr-operated. Deep-etched satin aluminum panel, rugged grey wrinkle steel cabinet.

VTVM PROBES	KIT	Wired
Peak-to-Peak	$4.95	$6.95
RF	$3.75	$4.95
High Voltage Probe-1		$6.95
High Voltage Probe-2		$4.95
SCOPE PROBES		
Demodulator	$3.75	$5.75
Direct	$2.75	$3.95
Low Capacity	$3.75	$5.75

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TELEDUCATION PROGRESS

. . . *An Astonishing Growth in a Short Time* . . .

WHEN we first started our mass-teleducation drive in 1945, educators were aghast at our idea of *Teleview Teaching*. We had stated: *"Outstanding educators [can] now lecture via teleview from central teletoriums. . . . Thus one teacher can lecture and instruct hundreds of classes. . . . Supervisors keep order in classrooms, collect notes, supervise tests. . . ."* This, in 1945, was arrant heresy to most orthodox pedagogues and we were roundly denounced for our vapid "dreams." Even as late as 1951 and 1955–56,* most educators still could not see MASS teaching via television. However, several far-seeing men in a few isolated locations in this country started a number of modest teleducation projects, all of which succeeded rapidly.

What probably convinced most die-hard educators that teleducation was *"the most significant thing going on in America today,"* in the words of authoritative Dr. Alexander Stoddard,† was the pioneer development inaugurated in September, 1956, in Hagerstown, Md. Here, at the time, 6,000 children in 6 elementary and 2 high schools were being educated via a local TV closed-circuit network.

Last year, in our editorial "The U.S.A. at Bay,"** we alerted every member of Congress and all key educators throughout the country to our national danger of continuously falling behind Russian mass science education. We once more emphasized that MASS NATION-WIDE TELEDUCATION was the answer.

Let us publicly voice our sincere appreciation here for the hundreds of enthusiastic and constructive letters we received at that time from US Senators and Congressmen as well as prominent educators from every part of the country.

Whatever small part we played in the present phenomenal teleducation development now mushrooming all over the country, we feel more than well repaid, although the achievement is still far from the goal we visualized in 1945—but more of this anon.

As this is written in early October, these are the present teleducation statistics:

Closed Circuit: Between 60,000 and 75,000 students of all ages obtain part of their education by *closed-circuit* TV in about 500 individual schools of all types. For some students, it may be 1 hour or less a week; for others, as much as 1 or 2 hours a day.

These figures are based on the annual survey by the Joint Council on Educational Television (July, 1958). It found that at least 133 closed-circuit systems are used by 119 institutions. Some of these are public-school systems. Teleducational Closed-Circuit Instruction—let us call it TECCI for short—is also used by The Armed Forces. It is not included in the JCET total.

Open Circuit: Between 8,000 and 10,000 schools now make use of on-the-air TV instruction. Some 10,000,000 students in all grades and educational institutions—1 in every 4 enrolled students in the US—view TV at some time in school. Perhaps half of these view academic or technical subjects *regularly*. The latter figures are our estimates, confirmed as "reasonable" by the US office of Education.

There are 37 TV stations owned by educational institutions and at least 75% of the more than 500 commercial TV stations that now have varied educational programs, many aimed at schools and colleges. NBC recently began the first *nation-wide* college-credit telecasts with an ambitious physics course. In addition, an estimated 500 New York City and vicinity schools, with 2,000,000 pupils, are already participating in teleducation.

An astonishing and impressive beginning in a minimum of time which deserves country-wide acclaim.

Nevertheless, it seems certain to us that in the foreseeable future *all* TV teaching will be via teleducational closed-circuit instruction. There are far too many advantages for TECCI against present-day open circuit systems to enumerate all of them here. True, open circuit is the logical stopgap in the interim, because it takes much longer to install a nation-wide comprehensive closed-circuit network, such as we have foreseen over a decade ago. Yet we know that it must prevail in the end. Our broadcast stations simply cannot carry an all-day-long teleducation load, 5 days a week.

We have also continuously advocated in these articles that the present makeshift of using a number of TV sets scattered through the classroom is archaic and cumbersome. We require up-to-date, *large* wall projection TV, just as dozens of theatres and hotels all over the country are now using for sports events and business meetings via closed-circuit networks.

We cannot comprehend the short-sighted handful of our TV projection manufacturers who have not seen fit to mass-produce classroom TV production equipment that schools could buy at a reasonable price. *A large market is certainly waiting now.* And once more we should emphatically repeat our past admonition that teleducation *must be in color to be successful*—you cannot hope to teach, particularly such technical subjects as chemistry, electricity, electronics, engineering, etc., in black and white. Color is essential here—a MUST.

We also pointed out many times in the past that we have sufficient *good* teachers right now to instruct the millions via teleducation in the US. All we require is a nation-wide technically integrated closed-circuit network accessible at all times to the greatest teaching talent in our country.

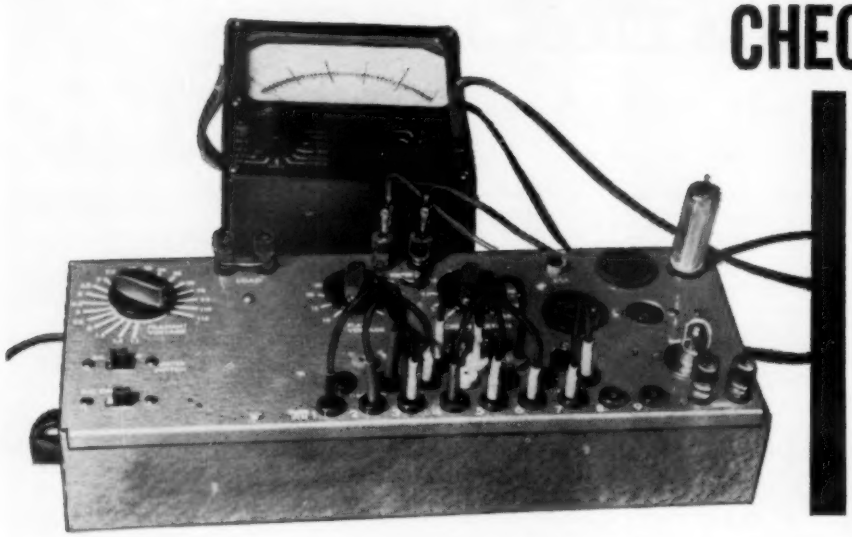
We are now living in THE most crucial period, when mass education is going through its greatest revolution in history. We in electronics have the consecrated duty to guide this new and vital educational development into its rightful path to success, always keeping in mind technical flexibility for future improvements that are bound to come. —*H.G.*

Tame, December, 1945; *Newspeek*, December, 1950; RADIO-ELECTRONICS, September, 1951. Also "Tec-Teleducation," *Forecast*, December, 1954; RADIO-ELECTRONICS, February, 1955, and May, 1956. (*Tame*, *Newspeek* and *Forecast* were the editor's Christmas brochures.)

†For 10 years chairman of the Educational Policies Commission of the National Education Association.

**RADIO-ELECTRONICS, December, 1957.

experimenter's economy TUBE CHECKER



Test for shorts and opens, emission, amplification, power output, noise and microphonics, transconductance and other important tube characteristics with an instrument you can build for about $20

By TOM JASKI

COMMERCIAL tube checkers have been getting bigger, better and more expensive. The experimenter who checks only a few tubes a month yet wants to know all he can about them is justifiably hesitant about investing over $100 in an instrument he uses so rarely.

To test for emission, transconductance, shorts and opens, noise, amplification, microphonics, gas, power output, rectification and maybe even interelectrode capacitances would certainly require a high-priced tube checker. On the other hand, to set up on the bench, each time, a complete experimental layout to test one tube would be a nuisance.

With minimum investment and maximum flexibility, the instrument described here circumvents both alternatives. It is not a complete tube checker, but neither is it a group of disconnected parts which have to be set up each time. Rather we should call it a basic tube-checking assembly, which can be swiftly adapted to just about any test you can think of.

Fig. 1 is the complete circuit diagram. The parts, purchased new, cost about $20 but, with some scratching and rummaging in the junkbox, you can probably reduce that by quite a bit.

Essentially, the unit consists of filament transformer T and its 20-point selector switch S4. To boost plate power for higher voltages, transformer T1 is included. If you end up with unusually low voltages, reverse the connections to one transformer primary. From the two transformers, two switches S3 and S5, single-pole 10-position switches tap off for appropriate plate and screen supply voltages. These are rectified by selenium rectifiers RECT 1 and RECT 2 and filtered by capacitors C1 and C2. Switch S2 adjusts for line voltage, but is optional. With the amount of control you have here, you might just as well hook up the transformer for 115 volts. There is the usual line switch, and a meter switch. The meter switch gives the choice of inserting a meter in either an ac or a dc plate supply. You will see the reason for this presently.

Connections to the tube-socket pins are made by inserting the phone tip on one end of a short length of flexible lead into the appropriate numbered jack. The other end of the lead is inserted in the desired circuit jack. There are six ground jacks, three plate jacks, two filament jacks (for center-tapped filaments) a grid and a screen jack. A pilot-lamp socket is connected to the filament-voltage switch and provides for testing pilot lamps. Two sets of binding posts are inserted in the plate circuit and connected with test links. In the grid circuit there is another test link on binding posts. The reason for these links is discussed later. A resistor and NE-16 neon lamp, also terminated in a phone tip jack, is the last item. The entire assembly is enclosed in a box measuring 2¾ x 5½ x 13 inches.

The voltages tapped off for the plate and screen supply are somewhat optional. I picked those which seemed most useful but, if you have other ideas, you can apply them here.

What will you need besides the checker to test tubes? That depends on the tests you want to make. Most tests require only a multimeter and a few resistors. For some you will need an ac milliammeter. For one a headphone is needed. But the nice part of the deal is that you are not tying up expensive instruments permanently. For all tests you will need a tube manual and some knowledge of how to test tubes. As we describe the various setups, you will soon learn what you need to know.

Heater continuity

Let's check for heater continuity of a 12AU7 for an example. First find the tube base in the manual. The heater pins are 4, 5 and 9 (center tap). Insert the tube in the nine-pin socket. Turn on the checker, and insert one lead in tip jack 4 with its other end in one of the grounded tip jacks. Now insert one end of the second lead in tip jack 5 and the other end in the one labeled SHORT. If the heater is good, both sides of the neon lamp will light.

To check for an intermittent heater or filament, take the pin out of the SHORT jack, set the filament switch for the proper voltage (12 in this case) and insert the same pin in the FIL jack. Then you can watch the filament light up, and keep it on as long as you choose.

Heater current

For this you will need an ac ammeter, preferably one that reads up to 1 ampere, or a shunted milliammeter which reads 1 ampere full scale. Insert one lead end into tip jack 4 (for the 12AU7) and the other end into one of the GROUND jacks. Set the filament switch to the proper voltage (12) and insert one of the meter's test prods into jack 5 and one into the FIL jack, and you'll read heater current at once.

Shorts and opens

Short and open tests are best made

with the tube warm and the heater on, because some shorts do not show up until the tube has warmed up. So, set up the filament voltage and connect the heater pins to GROUND and FIL jacks with two leads. Now insert a third lead into the SHORT jack, and test unoccupied tip jacks 1 to 9. If you encounter a short, the neon lamp will light up on both sides. When an element is normal, only one side of the neon lamp lights. If an element is open, the neon lamp will not glow at all. The setup for short testing is shown in Fig. 2-a. A test is being made for a cathode-to-screen grid short. For other shorts tests, you can start with all elements grounded except the heater. Then, remove the grounding jumpers in turn and plug into the SHORT jack. This detects shorts between the element being tested and all others.

Whenever the cathode tests shorted, you should determine the exact amount

R1—4,700 ohms, ½ watt
R2—3,300 ohms, ½ watt
R3—470 ohms, ½ watt
C1, 2—40 μf, 250 volts, electrolytic
RECT1, 2—selenium, 60 ma, 250 volts or two 60-ma 130-volt units in series
S1—dpst slide
S2—single-pole 3-position rotary, nonshorting
S3, 5—single-pole 10-position rotary, nonshorting
S4—single-pole 20-position rotary, nonshorting
S6—spdt slide
T1—power transformer: primary, 117 volts; secondary, 250 volts ct, 25 ma; 6.3 volts, 1 ampere (Stancor PS-8416 or equivalent)
T2—tube-checker transformer: primary, 125/115/105 volts; secondary, 1.1/1.4/1.5/2.0/2.5/3.0/3.3/5.0/6.3/7.0/7.5/12/25/30/35/50/70/85/110/117 volts (Stancor P-1834-3 or equivalent)
Chassis, 2¾ x 5½ x 13 inches
Socket, octal
Socket, noval
Socket, 7-pin miniature
Socket, loctal
NE-16 neon lamp and mounting assembly
Pilot-lamp socket
Binding posts (6)
Tip jacks (24)
Phone-tip plugs (19)
Grid or plate cap
Knobs
Miscellaneous hardware

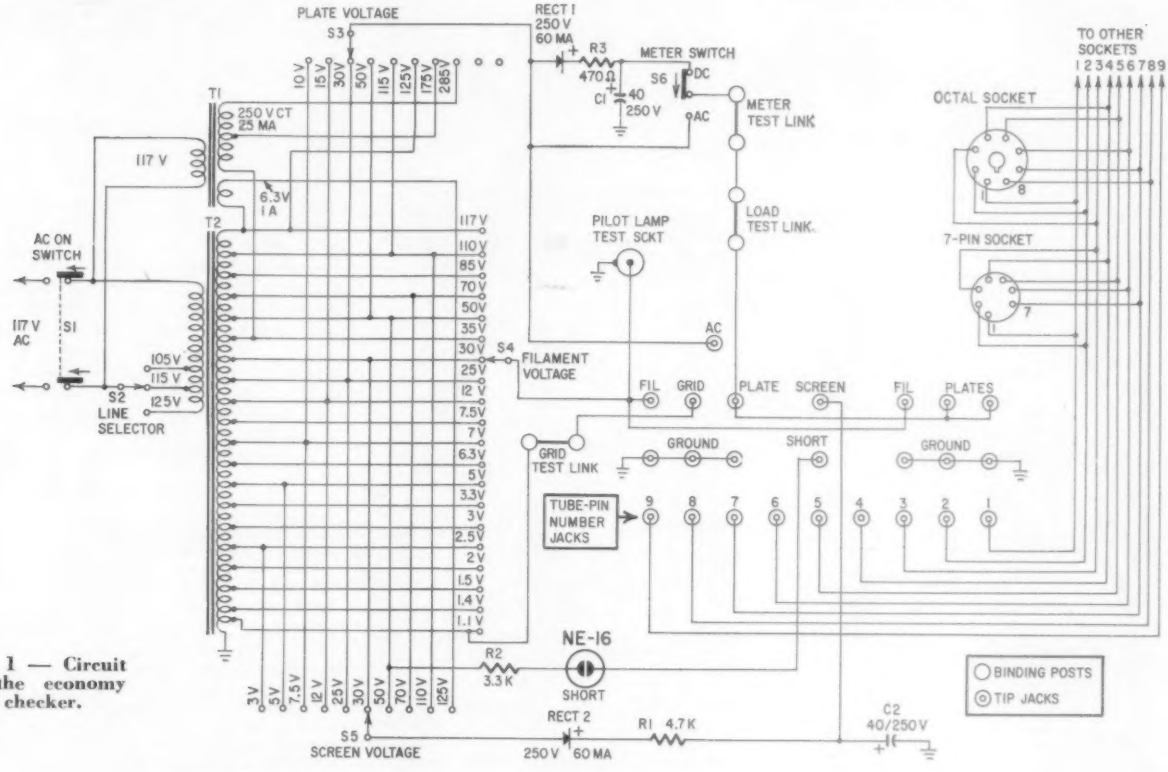
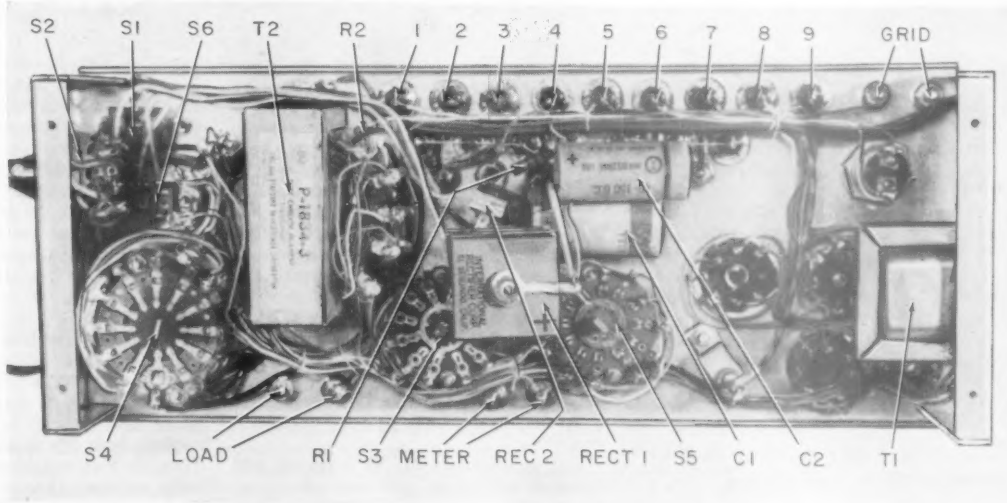


Fig. 1 — Circuit of the economy tube checker.



Inside the chassis. The author used two types of rectifiers which he happened to have.

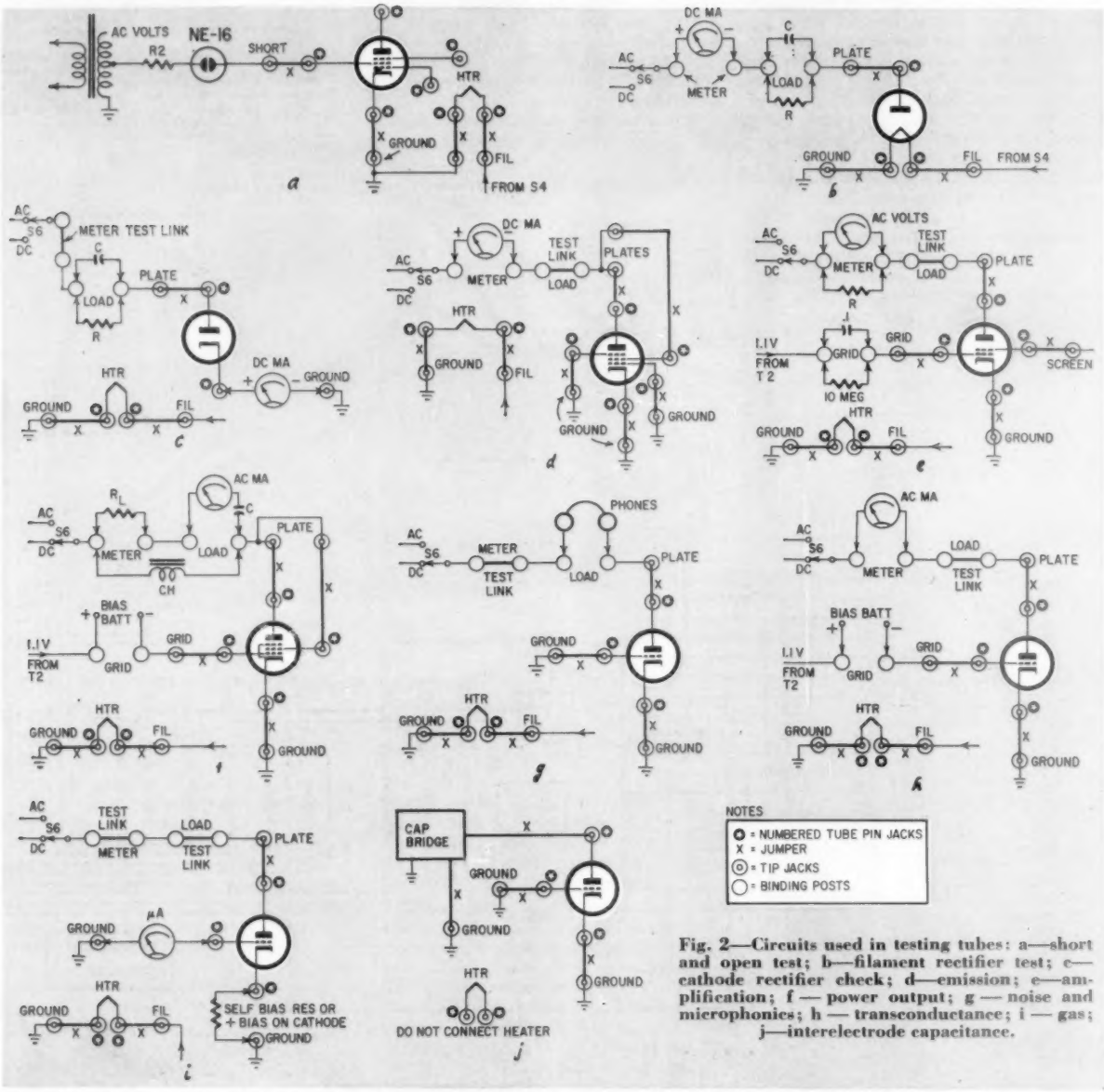


Fig. 2—Circuits used in testing tubes: a—short and open test; b—filament rectifier test; c—cathode rectifier check; d—emission; e—amplification; f — power output; g — noise and microphonics; h — transconductance; i — gas; j—interelectrode capacitance.

of cathode–heater leakage. To do this disconnect the SHORT testing lead, select a dc plate voltage of about 100 (70 is enough in most cases) and connect a microammeter to the meter terminals (test link open). Make sure the meter switch is on dc. Now connect the cathode to the PLATE jack. You will read some leakage current. For most tubes, this should not exceed 20 μa for 100 volts. In other words, with 70 volts you should not read over 15 μa. If you read more than 50 μa, definitely reject the tube.

A milliammeter with a 1-ma full-scale range can be used. On its scale 20 microamps will be only two scale divisions, but you will certainly be able to tell whether the tube should be rejected.

Testing rectifiers and diodes

Setups for testing rectifiers are shown in Figs. 2-b and 2-c. Here the meter switch is set for ac, but you use a dc meter. In series with the tube is inserted a resistor–capacitor combination. The capacitor should be at least 0.5 μf. The meter is connected across the METER binding posts with the link open for filament type rectifiers. For cathode type rectifiers (Fig. 2-c) the meter is connected between the tube's cathode and ground. The resistor will have to be a heavy-duty one, its value depending on the tube you are testing. For a 5Y3-GT which should deliver 125 ma per plate at 60 volts dc, the resistor can be a 400-ohm 10-watt unit. If you want to know the voltage, connect a voltmeter in parallel with the resistor.

For smaller diodes the voltages will have to be lower and the resistance higher. You can test selenium, germanium and silicon rectifiers and diodes with the setup in Fig. 2-c. If you have diodes with pigtails, you can insert these in the miniature or subminiature tube sockets.

Forward and backward diode current can also be measured. Simply switch the METER SWITCH to DC and for reverse current reverse the connections of the diode in the tube socket by swapping leads.

Emission checks

Similar to rectifier tests is the emission test. The setup is shown in Fig. 2-d. The METER SWITCH will be on AC, but again use a dc milliammeter. The plate and screen (if any) should be tested, but the emission contribution from grid or suppressor is so small you may as well ignore them, unless you have a very large tube. Most tubes are

tested with about 20 volts ac applied to the plate, except high-gain tubes such as the 6AC7, 6AG5, etc. These get only 10 volts. Output tubes are generally tested with about 50 volts ac and rectifiers such as the 5Y3-GT and 5Z4 with 75 volts.

A simple way to determine whether there is sufficient emission is to compare the tube you are testing with a tube you know is good. I have one good specimen of a number of tubes which I test periodically on hand, marked with all its values on a sticker, to use as references for tests.

However you can figure approximately. With the grid (and suppressor, if any) grounded you should read about one-third of the rated plate current with 20 volts on the plate. With the grid tied to the plate, you should read close to the peak rated cathode current. In other words, for the 12AU7 you should read 3 ma and 60 ma, respectively. The method you use depends on what meter you have available. But remember, a tube with a grid-to-plate short in the method in which the plate and grid are tied together will show normal emission, as will a tube with a cathode-to-grid short in the other method. So don't forget to check for shorts.

If you often check the same or similar type tubes, you can easily make yourself a chart showing emission values which are acceptable, doubtful and bad.

Amplification test

This test, shown in Fig. 2-e, is often called a transconductance test. It is really not so. What is measured is the ac amplification of the tube. It simply tests the amplification of a tube at rated voltages and zero bias. However it is a useful test, because R can be changed to any contemplated value and the performance of the tube determined. Also you could use a resistor for self-bias and determine performance in a duplication of anticipated design values.

Checking power output

This test is one that strains even the multiple connections available in this box. Fortunately it is not made frequently. Resistor R_L (see Fig. 2-f) is the normal load resistance for the tube, the capacitor (C) should be at least 0.5 μf and the choke (CH) must have about four times the impedance of the load resistor. Reading the alternating current, you can then calculate the power output from the formula $W = I^2R$. If you have a power output meter, the load resistor is sometimes built in. Multimeters which have a power output scale do not, as a rule, have a load resistor built in; they are designed to match a 500-ohm load. In effect, they measure an ac voltage. The voltage applied to the grid is 1.1 volts and the bias battery should have the same voltage. If you do not need a screen voltage, you can use the PLATE VOLTAGE selector with the METER SWITCH on AC, and a bias battery connected to the LOAD terminals to get a higher test voltage for the grid. To do this, use the SCREEN jack and rectifier for the plate voltage.

If you don't have an ac milliammeter but *do* have an ac voltmeter (preferably a vtvm), you can read alternating current by using a precision shunt resistor of 1, 10 or 100 ohms, depending on the current to be read and the scales on your meter.

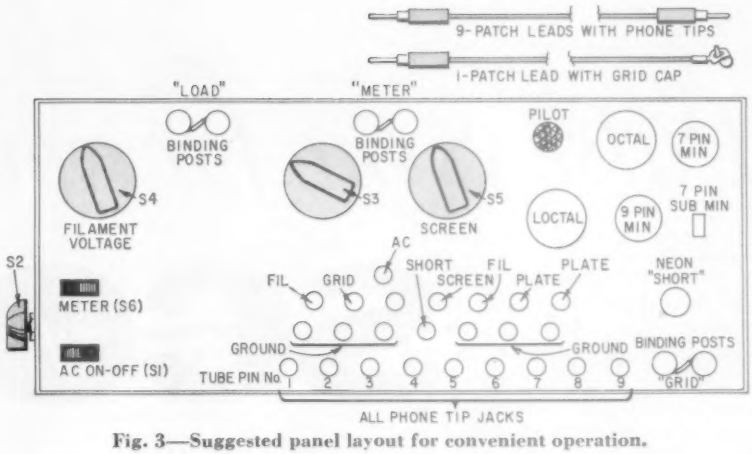


Fig. 3—Suggested panel layout for convenient operation.

Noise and microphonics

This test is shown in Fig. 2-g and is self-explanatory. The object is to apply approximately normal voltages to the tube and to listen for noise. To test for microphonics, tap the tube lightly while listening. If it rings and the ringing persists, even a little, after a tap, you have a microphonic tube.

Measuring transconductance

This is probably the most used test, after emission and shorts. It (see Fig. 2-h) requires an ac milliammeter (or as before, an ac voltmeter across a precision resistor. The meter must be isolated from the dc so it does not deflect on direct current as some multimeters do. This is done by placing a large paper capacitor in series with the meter. Its impedance will be negligible for the small meter current, if you use at least 2 μf.). The bias voltage is that specified by the manufacturer.

With a 1-volt input (plus the bias) a 1-ma ac meter would read 1/1,000 of the transconductance in micromhos. In other words, full-scale reading on a 1-ma meter would indicate 1,000 micromhos. With the 1.1 volts available from the transformer, you make a correction, the transconductance is 909 times the reading on a 1-ma meter scale, in micromhos. For rough work the 1,000 times is close enough.

If you have an ac voltmeter which has a 1-volt scale, and you use a 100-ohm shunt, the value you read must by multiplied by 9,090, because your meter in effect reads 10 ma full scale.

In most tests, when you are checking one section of a dual tube, it will be best to ground all elements of the unused section. But if you cannot ground them all, do not ground *any* of them.

A check for a gassy tube (Fig. 2-i) is made with the specified plate voltage and the grid at the cutoff bias listed by the manufacturer. You can use self-bias, but it is better to use an external bias in the grid circuit (use the binding posts marked GRID).

If the meter in the grid circuit shows any current at the specified bias voltage, try a slightly higher voltage, because tubes are not all exactly as specified. However, if you fail to get the tube cut off at 20% over cutoff bias, it is certain to be gassy. Even between the specified value and the 20% higher point there is some doubt. The meter will have to be a microammeter, with a 50-μa or lower scale. Many late-model multimeters measure these low currents.

Other tests

You will seldom measure interelectrode capacitances. It requires a sensitive capacitance bridge. However, the setup is shown in Fig. 2-j.

The experimenter who has read this far can now easily see how still more tests can be made. For example, you can make a coil with two windings and attach leads with phone tips to both coils, and use them to test a tube's ability to oscillate. Some tubes which check out fine refuse to oscillate well. This sometimes happens in pentagrid converters.

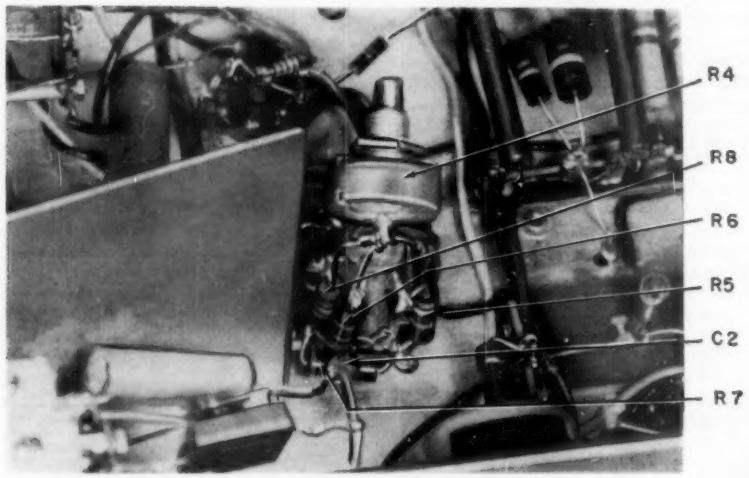
You can use the box as a base for external connections, with supply voltages obtained from the box. Thus, you can connect outside oscillators to the grids for tests such as phase-reversal mixer transconductance. Few experimenters will get into this and, for those who must, data are available in references such as the RCA *Radiotron Designers Handbook*.

As it stands, I find this checker to be a most useful tool, for it does not limit me to any one type of test and it is easily set up in seconds for any test I would want to make. Once you have used it a few times, I think you'll agree it is the "most" tube checker you can get for the least money, unless you spend all day checking tubes. END

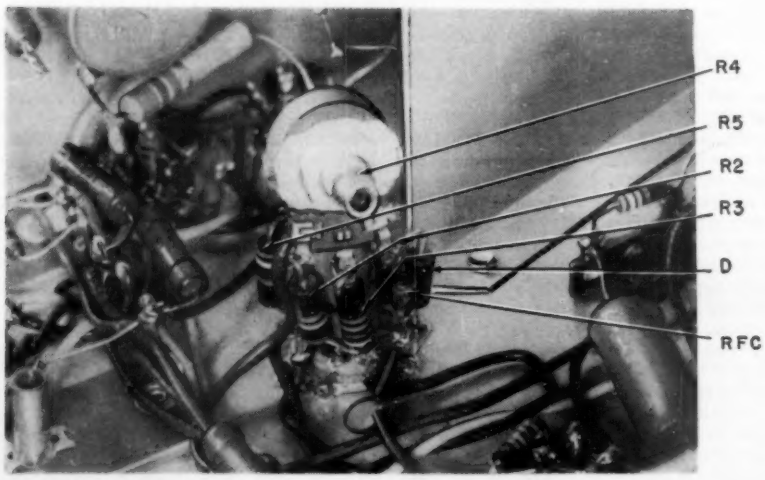
Pulse Sync for your SCOPE

Add a Schmitt trigger and stop scope-trace wandering when you switch from point to point in a circuit

By DANIEL MEYER



Compact assembly makes the modification easy to install.



Another view of the pulser installed in the scope.

HOW many times have you seen an oscilloscope trace go wild when you moved the scope's probe from one point to another in a circuit? Almost always, is probably the answer unless you own a relatively expensive oscilloscope.

This difficulty can be traced to the sweep and sync circuits used in most scopes in the under-$200 class. The sweep circuit in most of these is a simple cathode-coupled multivibrator. This multivibrator is very similar to the one used as a horizontal oscillator in TV sets. The main difference is that the frequency of the scope's multivibrator can be varied over a wide range by changing the R-C time constant between the two tubes.

Sync signals, consisting of a portion of the signal being viewed, are applied to the grid of the first tube section. These signals are tapped off the scope's vertical amplifier and fed to a sync amplitude control which controls the amount of sync signal reaching the sweep multivibrator. This is all well and good, but a multivibrator is critical when it comes to both the voltage and waveshape of the sync signal. Sync signals reaching it must have the following characteristics to give reliable triggering (see Fig. 1):

Rise time	0.1 microsecond
Decay time	1.0 microsecond
Shape	Peaked
Amplitude	Constant

If the pulse has a slow rise time, like a simple sine wave, the multivibrator needs considerably more sync voltage to lock in at the same frequency as the signal being viewed than it would if rise time were fast. The variation in signal level and waveform being applied to the sweep circuit is what causes the scope to lose sync when the probe is moved from one point to another in a circuit. For example, if the scope is adjusted to check hum

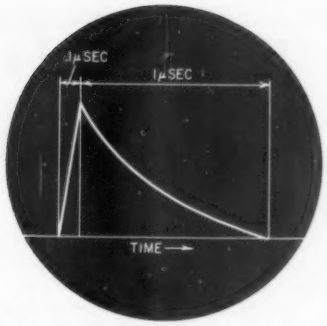


Fig. 1—Characteristics of a good sync signal.

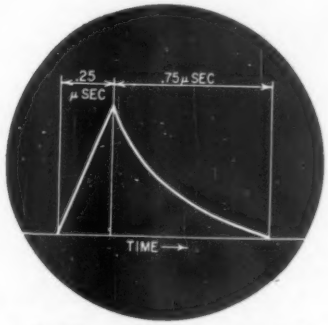


Fig. 2—The pulse developed by a Schmitt trigger circuit.

at 60 cycles and the probe is moved to a vertical oscillator circuit, the scope will probably lose sync because of the difference in waveforms, even if voltage levels are approximately the same.

Try a Schmitt trigger

We can supply the sweep multivibrator with an almost ideal synchronizing pulse with a simple one-tube circuit known as a Schmitt trigger. A typical pulse produced by this type circuit is shown in Fig. 2. Fig. 3 is a basic Schmitt trigger circuit and helps explain the action of the circuit. A Schmitt trigger consists of two amplifiers having direct plate-to-grid and cathode-to-cathode coupling. The circuit has two stable states—V1 conducting, V2 cut off; V2 conducting V1 cut off. The changeover from one state to the other is very rapid, producing fast rise and decay times from each side of the circuit. Either one can be used for triggering. The dc voltage applied to V1's grid determines which state the circuit is in. If the grid voltage is above a certain value, V1 conducts and V2 does not. If V1's grid voltage is below this value, V2 conducts and V1 does not. Each time V1 crosses this threshold, the circuit changes state. In practice, the voltage is higher when moving the grid in a positive direction and lower when moving it in a negative direction. The two voltage levels are called the upper and lower hysteresis limits of the circuit.

To trigger the circuit, V1's grid voltage must cross the particular hysteresis limit which will change the state of the circuit. If V1 is already conducting, driving the grid voltage more positive through its upper hysteresis limit has no effect, but driving the grid voltage more negative through its lower hysteresis limit cuts off V1 and starts V2. V1 is normally off in this circuit, and the symmetry control is adjusted to turn it on at the proper time after the circuit is triggered by a positive-going signal. The symmetry control is adjusted to place V1 halfway between its upper and lower hysteresis limits. This is the most sensitive possible setting for the trigger circuit.

Now, let's go to Fig. 4, which shows the circuit that gets added to your scope. When a signal of sufficient amplitude reaches V1-a's grid, the circuit switches states and produces a fast-rising pulse at V1-b's plate. This pulse is differentiated by C3 and R9. The waveform now closely resembles the pulse shown in Fig. 1. When the grid voltage falls, the circuit again switches states and the diode shunting the choke in V1-b's plate circuit conducts, clipping the negative-going pulse.

This signal is fed to the input grid of the multivibrator. The sync amplitude control R9 is also connected to this grid. It controls the size of the pulse by changing the time constant of the differentiating circuit of which it is a part. If this is not done, the impulse will be strong enough to hold one cycle of the waveform being viewed over most of the fine-frequency range.

R9 and R10 are original scope components, but if these parts in your scope do not have the values shown in the schematic (Fig. 4) they must be replaced with the specified values.

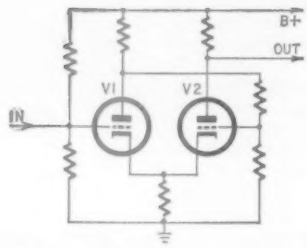


Fig. 3—Basic Schmitt trigger uses two triodes with direct plate-to-grid and cathode-to-cathode coupling.

Adding the pulser

The original pulser was built on a Vector socket. This makes it easy to find room for the parts, and the unit can be completed before it is installed in the scope. The pulser should be mounted as close to the sweep multivibrator as possible. The output pulse will be steeper if it is not loaded by any unnecessary wiring capacitance. The lead to the sync amplitude control should be as short and direct as possible for the same reason. B-plus for the pulser can be obtained from a 120-volt line if your scope happens to have one. If not, a dropping resistor and bypass filter capacitor must be used to reduce the voltage applied to the tube. The pulser draws 13 ma so the required resistor can be found with the following formula.

$$R = \frac{X - 110}{.013}$$

where X equals the available voltage.

Note that the circuit, with the values shown, will not work at voltages much over 130. However, it will work with reduced pulse output—down to 70 or 80 volts. So use a larger rather than a smaller resistor if the value calculated is not a standard size.

To adjust the symmetry control, connect the B-plus voltage but leave

R1, 2—100,000 ohms
R3—47,000 ohms
R4—pot, 50,000 ohms, 2 watts
R5—3,900 ohms, 5%
R6—6,800 ohms
R7—10,000 ohms
R8—18,000 ohms
*R9—pot, 100,000 ohms, 2 watts
*R10—470,000 ohms
All resistors 1-watt 10% unless noted
C1—0.25 μf, 400 volts
C2—15 μμf, disc ceramic
C3—100 μμf, disc ceramic
D—IN56-A
RFC—1 mh
V1—6U8-A
Vector socket, 9-pin
Miscellaneous hardware
**These parts are in your scope. However, their values may differ. If so, replace them with the values shown.*

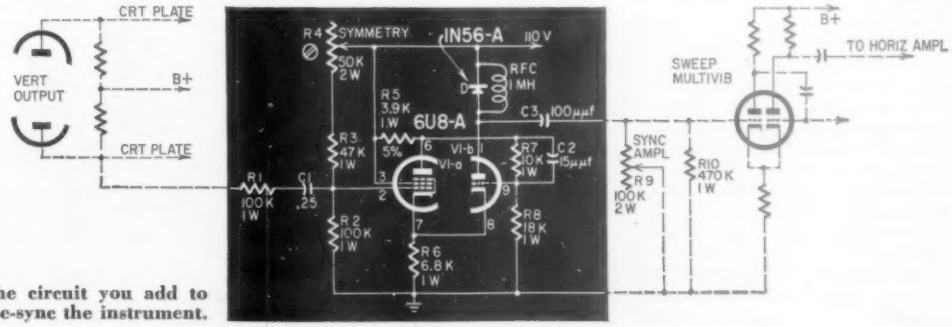


Fig. 4—This is the circuit you add to your scope to pulse-sync the instrument.

the input and output temporarily free. Then connect the input to an audio oscillator set at about 15,000 cycles. Connect the pulser's output to the scope's vertical input. Turn the symmetry control until an output is observed on the scope. Adjust for equal spacing between the positive pulses and the clipped negative pulses. (See Fig. 5.)

Make this adjustment with the least

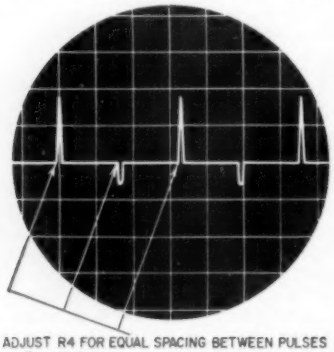


Fig. 5—When you get this pattern on your scope screen, the symmetry control is adjusted properly.

possible signal that will cause the circuit to switch. If an audio oscillator is not available, this adjustment can be made with a 100-ohm potentiometer across the heater line with its tap connected to the pulser's input. Adjust as before for triggering with the least possible signal. Now lock the setting with a drop of paint or glue on the shaft of the symmetry control potentiometer. No further adjustment is needed unless the trigger tube is changed.

It takes about 5 volts to make this circuit switch states. This is equivalent to a trace about ¼ inch high, and the scope will not synchronize on a signal smaller than this. If desired, bypass the pulser with a spst switch so you can observe signals too small to trigger the pulse circuit. A sync amplifier can be used ahead of the trigger generator if pulsed sync is desired at extremely low levels. Such small signals are generally of no value in service work, so this feature was not incorporated in my unit.

Operating the scope with the pulser installed is almost the same as using standard sync. Turn the sync amplitude control all the way down. With a signal applied to the scope's vertical input, adjust the fine-frequency control until the signal is reasonably close to the point where it should lock in. Now slowly advance the sync amplitude control until the picture jumps into sync. Advancing the control beyond this point will cause the number of cycles of the signal on the screen to decrease until only one is left as the control approaches full output.

Using the scope should be much easier with pulse sync installed. The stable trace produced should make service work less troublesome and much more pleasant. END

Flyback and Yoke Tester

By W. G. ESLICK

AT one time or another every service technician has wanted to know if the flyback or yoke was actually bad before removing the old unit. I have repaired many sets for other shops and dealers whose verdict was "a bad transformer" which turned out to be damper circuit troubles or "a bad yoke" which turned out to be a shorted capacitor in the yoke. To solve the problem I designed a flyback and yoke tester.

The unit is a blocking oscillator keyed by raw ac on the 6V6's plate and screen. The oscillator is keyed 60 times a second and operates at a low audio rate. A 6.3-volt heater transformer (T1) is used here, the heater winding being the plate winding.

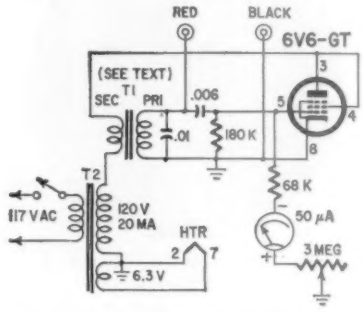
The power transformer was salvaged from an old uhf converter and has a 6.3-volt heater winding as well as a high-voltage winding rated at 120 volts at 20 ma. The meter I used comes from an old vtvm. No special layout is followed; that is left to you.

To check a flyback, disconnect all yoke, width and afc coil leads, leaving nothing but the high-voltage rectifier's filament. (To clear up a point, all leads won't have to be removed, just open leads so that the transformer isn't loaded by any windings. In a majority of recent sets without any width coils, just open one yoke lead.) When testing yokes, one end of any internal resistors or capacitors must be disconnected.

The meter scale is colored red to 45 on its 100-volt scale (or 45% of scale) and green from 55–100 (full scale). At 67 (on the 100-volt scale, or 67% of scale) a calibrating mark was made. Most good transformers read higher than this calibrating mark.

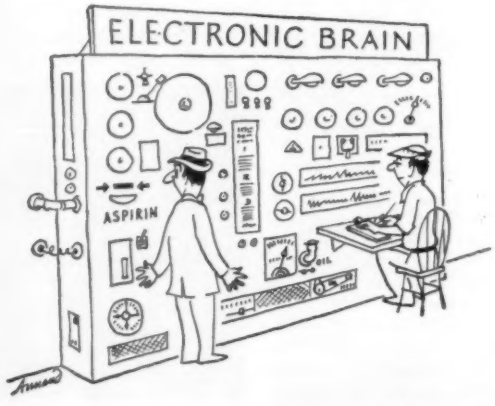
The black lead from the tester is connected to the flyback lead going to the plate of the high-voltage rectifier and the red lead from the tester goes to the horizontal plate lead. After warmup, calibrate the unit and test the transformer.

As stated, most flybacks read higher than the calibrating point. However, testing yokes is something else. For example, on Crosley 17- or 21-inch models using a vertical chassis with a capacitor between the yoke and flyback, a good yoke (horizontal section)



reads OK at the calibrating point or very nearly so, while a bad yoke makes the meter fall back to 5 (on the 100-volt scale). On an Admiral 22A3 chassis, a good yoke reads approximately 40 (horizontal section). Of course, this test only detects shorted flybacks. To check for opens, you naturally return to your ohmmeter.

You can see that a good–bad scale is really useless unless scales for low- and high-impedance yokes and air- and iron-core transformers are used. To make this instrument more valuable and to insure 100% accuracy, I made a chart showing what every good transformer and yoke reads. Then it's simple to find a bad one. On every set that you work on (and have the time) find the reading of the flyback and yoke. This pays off in time and labor saved. END



RF WATTMETER FOR ~~MOBILE RADIO~~ SERVICING

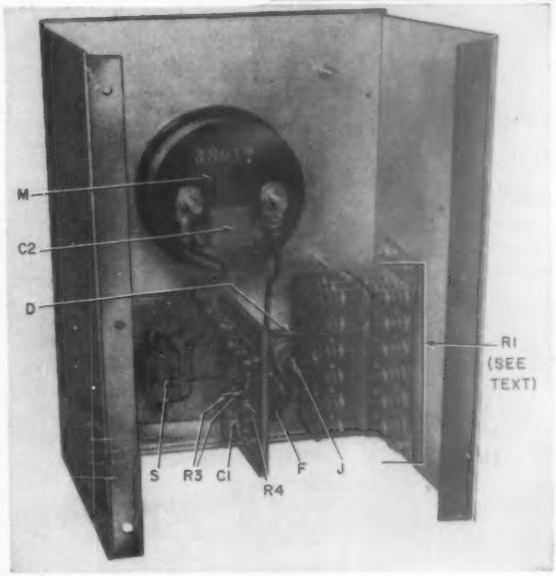
If you plan to repair mobile transmitters you will need some additional test instruments. This one you can build for yourself

The one control on the meter switches the instrument to either its high or low range.

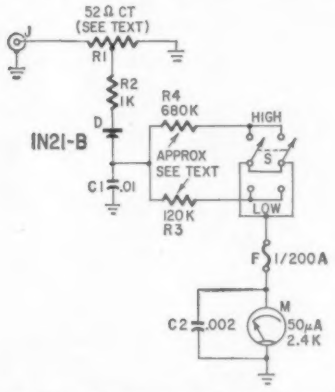
By R. A. THOMASON

MOBILE two-way radio systems are springing up all over the world. They are used by municipalities, utilities and particularly private industry. Repairing this equipment can turn into a major source of income for the well-equipped shop, an income which generally is not seasonal.

The high dependability and long equipment life demanded by these customers require quality maintenance. To do this work, the technician has to make a sizable investment in test equipment. One instrument he will need is an rf wattmeter. This article shows how to build such a unit at a moderate cost.



The resistor bank (R1) is fastened to one side of the case. Note its construction.



R1—470-ohm 2-watt carbon resistors (36) (see text)
R2—1,000 ohms, ½ watt
R3—120,000 ohms, ½ watt (see text)
R4—680,000 ohms, ½ watt (see text)
C1—.01-μf disc ceramic
C2—.002 μf mica
D—1N21-B
F—1/200-ampere fuse with holder
J—coaxial connector
M—50-μa meter, 2,400 ohms, Simpson model 29 or equivalent
S—dpdt toggle
Case, 5 x 6 x 8 inches
Miscellaneous hardware

Fig. 1—Circuit of dual-range wattmeter.

It has high and low ranges—0–80 and 0–4, respectively.

Construction is straightforward and circuitry (see Fig. 1) simple. All components are mounted in a 5 x 6 x 8-inch aluminum case. The only critical portion is resistor bank R1. It is composed of thirty-six 470-ohm 2-watt resistors. They are in two groups of 18 connected in parallel, with the groups in series. This forms a 52-ohm termination rated at 72 watts. Carbon resistors must be used for the termination to be a pure resistance. Resistor R2 is connected at the junction of the two groups.

To make the resistor bank, cut out four 2 x 5-inch pieces of brass shim stock or copper sheet. Drill 18 1/16-inch holes in 3 rows, 6 holes to a row, all spaced ½ inch apart. Trim all the 470-ohm resistor leads to ⅜ inch. Thread one lead of 18 resistors through the shim stock so the resistor is flush with the metal strip, bend the lead over and solder. Repeat this procedure on the other end. Make another bank in the same manner, using the remaining 18 resistors. Trim excess shim stock and solder the two banks together. Leave enough shim stock at one end for mounting the bank to the chassis (see photo).

The coax connector and resistor bank are mounted so that they can be directly connected (see photo). This keeps the inductance low and improves the frequency response. A dpdt switch is used to insure a good contact.

I used a 4½-inch, 0–50-μa meter as an indicator. Fig. 2 is a scale, calibrated in watts, which may be cut out and cemented over the existing scale.

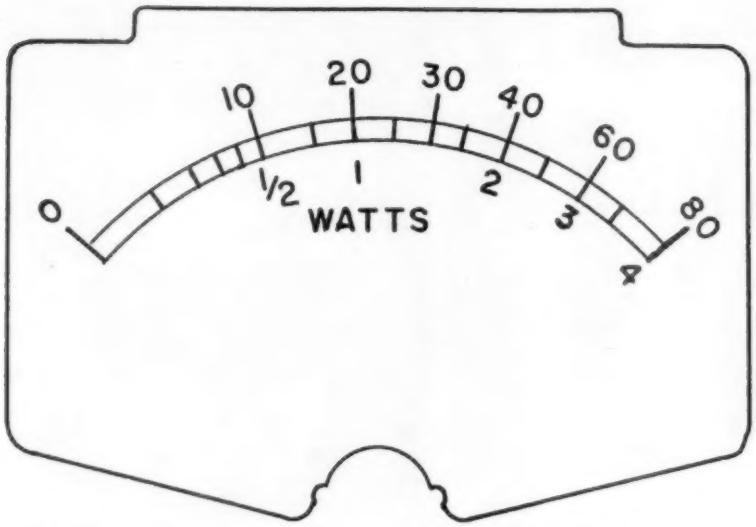


Fig. 2—Paste this new meter face over the existing 50-μa scale.

Capacitor C2 is connected directly across the meter terminals. This keeps rf out of the meter movement and prevents possible damage to the meter.

A 1N21-B is used as the meter rectifier because of its superior frequency-response characteristics. A cheaper general-purpose diode (1N48) may be substituted if a wide frequency range is not needed. Of course, correction charts could be made.

The meter is calibrated with a commercial wattmeter, changing calibration resistors R3 and R4 for the low and high ranges, respectively, as necessary. It is best to calibrate for points above center scale. You will probably have to parallel resistors to get the exact value. Potentiometers could be used; however, once this resistance is correct no further adjustment is ever likely to be needed.

If a wattmeter of known accuracy is not available for calibration, measure the power output of several transmitters and average this power against the manufacturer's rating. This, of course, will not calibrate your meter exactly, perhaps within 15%. However, this will reduce its usefulness very little. Once an average output level is determined, individual performance can be readily checked. END

VICE JAWS AS HEAT SHUNT

By J. C. ALEXANDER

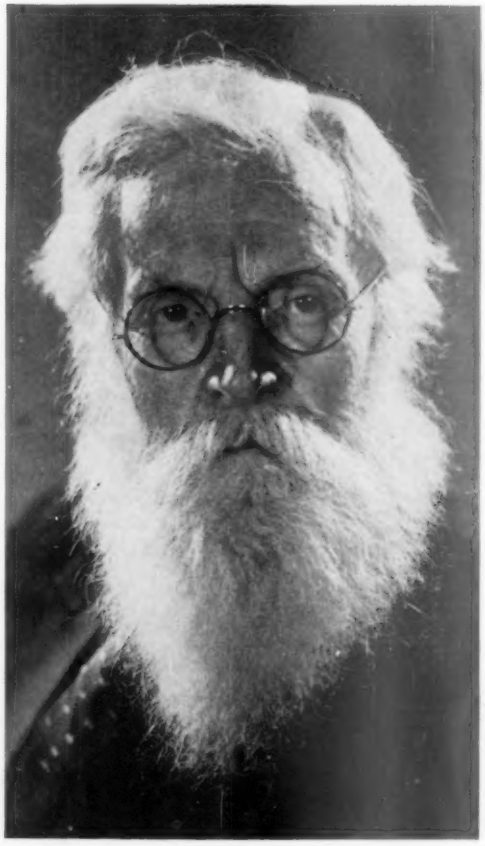
When a wire extension must be soldered onto a short component lead (a technique used by many technicians

and experimenters to salvage used parts from an old radio or amplifier), heat conduction down the wire lead often ruins the component (resistors change value and the wax melts out of the paper capacitors).

There are many ways to shunt the heat away from the components, but the most effective method I have ever used is shown in the photo. By using the vise jaws as a heat shunt, there is practically no danger of injuring a component regardless of the amount of heat needed to make the connection. And since you can use more heat with complete safety you run less of a chance of getting a cold solder joint.

DON'T LET THE WHISKERS FOOL YOU . . .

not every "guy with a beard" is Santa Claus—and not everybody who advertises "tubes cheap" is giving you a bargain. You can be sure you're getting a fair shake though when you buy from RADIO-ELECTRONICS mail order tube advertisers. It's been our policy since January 1956 to insist that all mail order tube advertisers tell you that their tubes are new and unused—or seconds, rejects, or otherwise imperfect as the case may be. This has cost us advertising revenue—but it protects our readers—so it's worth it.



2-way stereo amplifier

handles both channels through the same tubes—cuts cost and space requirements

By B. B. BAUER, WILLIAM C. BACHMAN and J. M. HOLLYWOOD*

THIS new amplifier was designed to solve two of the most troublesome problems of stereophonic reproduction—those of cost and space. It is called a two-way amplifier because it uses single push-pull stages to amplify two independent signals, and can thus handle both channels of a stereophonic recording. And it does so with quality and power output roughly equivalent to that of a single push-pull amplifier with the same tubes. Separation between channels is greater than 25 db, and cost and bulk are only a little greater than that of a single amplifier and certainly a great deal less than that of the two push-pull amplifiers that would be needed to do the same job.

But how is this remarkable feat of amplifying two signals with the same amplifier accomplished? We are all familiar with the reflex circuit in which the tubes are used to amplify once at radio frequencies and again at audio frequencies. Here we have to amplify not only two audio frequency signals, but two of almost identical program content.

The basic principle is well known and has been used in telephone work to supply additional lines and for other purposes. It is best illustrated by the circuit of Fig. 1, a push-pull audio output stage. It will be seen that the circuit containing T1 and T3 is a conventional stage with input and output transformers. A signal applied to the input winding of T1 drives the grids in opposition, so that the tubes work in push-pull and supply a signal to the output of T3, which may be a voice-coil winding. Since the plate currents are opposite and equal, no signal voltage will appear in T4 (if the tubes are properly balanced).

A signal applied to T2 drives both grids in phase, and the tubes operate in parallel. The plate currents are now in phase and equal, and therefore will produce no signal in the output winding of T3, but will produce output from T4. Since the circuit can handle two independent signals with little interaction it could conceivably be used to amplify the left and right stereo channels independently of each other.

With such an apparently simple and easy solution, one may ask why it has not already been tried. The answer is that this circuit cannot give excellent results. To cite the most obvious point, the push-pull channel has more power-handling ability than the parallel one, for equal distortion and frequency response. To make an entirely satisfactory amplifier it was necessary to modify this simple circuit drastically.

To understand how such a modification can take place, it is necessary to know a little more about the correspondence between vertical–lateral and 45-45° recording. Fig. 2 is a section of a record groove. Now think of the cutter or pickup stylus moving from point P to point Q. This movement is the resultant of two motions at an angle of 45° from the vertical or horizontal axis. The lateral motion from left to right is the result of motions L and R aiding, and may be expressed as their sum (L + R). The vertical movement results from L and R opposing, and is expressed by their difference (L−R). Note well that exactly the same motion can be expressed as a horizontal motion H of 0.707 (L + R) and a vertical motion V of 0.707 (L−R). By using the factor 0.707 (the sine of a 45° angle) a 45-45° modulation can be expressed as a horizontal–vertical modulation in which the sum signal (L + R) is recorded horizontally and the difference signal (L−R) vertically. The two systems are identical; they are merely expressed by a different set of equations. Generally, it may be observed that the bulk of the power is in the sum signal, while the difference signal carries the stereophonic information.

These principles may be combined to reproduce both channels of a 45-45° recording equally. Fig. 3 shows how this could be done with a horizontal-vertical pickup. The horizontal section feeds the sum signal (L + R) to the input of a push-pull stage through transformer T1. The vertical section picks up the difference signal (L − R) and feeds it to the two grids of the stage in parallel through transformer T2 and the center tap of T1. Output transformers T3 and T4 are similarly arranged, with the secondary of T4 connected to T3's center tap so that the difference voltage D aids half the

* CBS Laboratories, Stamford, Conn.

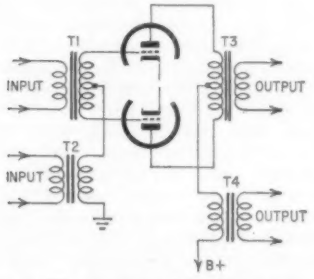


Fig. 1—The same push-pull stage amplifies two sets of signals or programs.

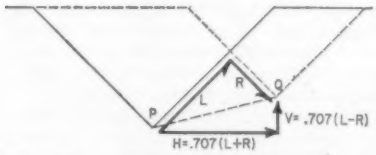


Fig. 2 — The relationship between 45-45° and vertical–horizontal recording.

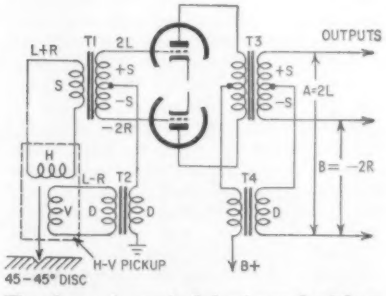


Fig. 3 — A vertical–horizontal pickup illustrates the two-way principle.

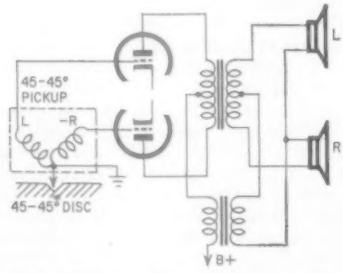


Fig. 4—How a 45-45° disc is played through a two-way amplifier with a 45-45° pickup.

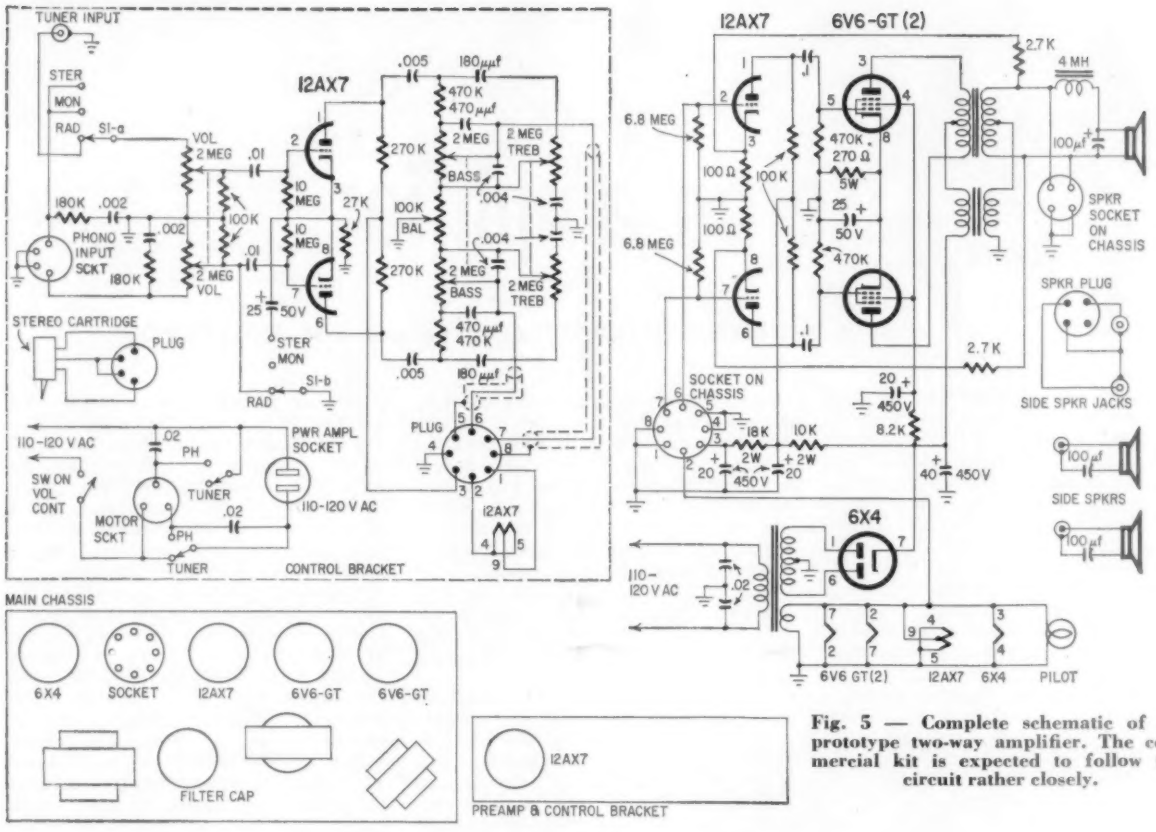


Fig. 5 — Complete schematic of the prototype two-way amplifier. The commercial kit is expected to follow this circuit rather closely.

sum voltage (+S) and opposes the half of the sum voltage (−S) generated in the other half of the transformer. The voltages between the open end of T4 and the two ends of T3's secondary are:

$$A = D + S = (L - R) + (L + R) = 2L$$

$$B = D - S = (L - R) - (L + R) = -2R$$

Thus we can produce two independent L and R signals from a 45-45° disc with a horizontal–vertical pickup, the special push-pull stage and matrixed output transformers. The right-channel signal appears with a minus sign ahead of it, which in practice means simply that the leads of the right-channel loudspeaker must be reversed to put it in phase. The output will sound exactly like the product of two independent amplifiers.

Now, how can we adapt this stage to the output of a 45-45° pickup? Let us look again at Fig. 3. The difference signal (L − R) is applied to both input grids in parallel from the secondary of T2 through the two halves of T1's secondary winding. Added to this signal, at the upper grid is the sum signal (L + R) and the same signal is subtracted from it (applied out of phase) at the lower grid. Thus the upper grid's voltage is:

$$(L - R) + (L + R) = 2L$$

and that of the lower grid:

$$(L - R) - (L + R) = -2R$$

The voltages at the two grids are equal but opposite to those supplied by a 45-45° cartridge.

By reversing the phase of one of the pickup coils and connecting as indicated in Fig. 4, a virtual sum signal in push-pull and a virtual difference signal in parallel is still supplied to the single stage. A four-terminal stereophonic pickup can readily be connected to supply this type of signal, and three-terminal pickups can be manufactured with proper polarity for this use.

It may be pointed out that two single-ended amplifiers might be used instead of this all-push-pull arrangement. Such an arrangement would have the same advantages of compactness and economy as the two-way amplifier, but would not have the same quality or output power. The push-pull transformer which carries the sum signal that determines largely the quality and bulk of both stereophonic channels is not subject to saturation, and has the advantages of low distortion inherent in the push-pull arrangement. Saturation in the parallel transformer can be prevented by a suitable air gap. This will reduce the primary inductance, but that can be permitted because its effect (attenuation of the difference signal at low frequencies) will not cause noticeable loss of stereophonic effect. Rumble and mechanical feedback will also be attenuated, and thus may result in an actual net advantage. Symmetry of the system is preserved over a greater tolerance of tube and component variations than would be possible with two separate amplifiers.

A practical circuit—substantially in the form in which the amplifier will be manufactured—is shown in Fig. 5. It is intended for use with a ceramic pickup, properly phased to produce the L and −R signals. Two inverse feedback loops not only provide the usual benefits of negative feedback, but also increase the channel separation. Power output is 10 watts (20 watts peak) at 0.8% distortion for both channels combined. The amplifier will be available as a kit from the Heath Co. soon.

As a guide to those wishing to experiment with the arrangement, the push-pull output transformer should be a typical unit for the quality and power desired, having usual voice coil impedance. The center tap should be accurate, but negative feedback allows some unbalance to be tolerated. The transformer for the parallel component need not pass frequencies much below 250 cycles, and should have an output impedance one-quarter that of the voice coil, i.e., the same as half of the push-pull output transformer winding.

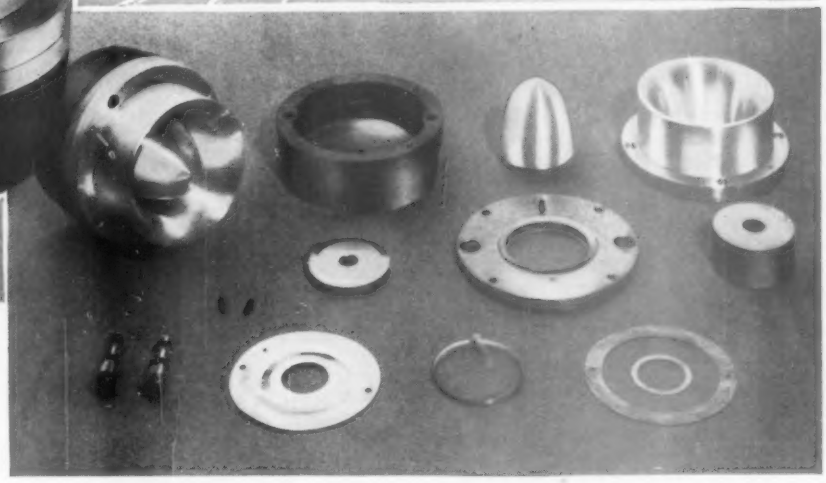
The authors wish to express their thanks to Dr. Peter Goldmark for his encouragement and suggestions, and to G. P. Maerkle for his part in developing the laboratory prototype. END

The RING RADIATOR

By GEORGE L. AUGSPURGER

A new development in high-frequency speakers, this high-efficiency unit responds smoothly from 2,500 cycles to well beyond the limit of hearing

The James B. Lansing 075 high-frequency Ring Radiator.



Complete 075 (upper left) and unassembled component parts.

EVER since the magic numbers "20 to 20,000" were trumpeted from the sales departments of amplifier manufacturers, conscientious audiophiles have sought a speaker system which would match the full frequency range of modern electronic equipment. The acceptance of tweeters and super-tweeters dates back several years, but only recently has the buyer become aware of the importance of smoothness and negligible distortion in these components and their effect on the listeners.

At the moment, of course, the electrostatic tweeter holds the spotlight. While several well-designed electrostatic units are available to the buyer, it is a little unfortunate that the great interest in the revival of such designs has obscured corresponding refinements in electrodynamic units. Although most of the latter are still compression driver and horn assemblies, a great deal of work has been done in refining the design of diaphragms and coupling chambers to extend the range of these units beyond the upper limit of human hearing.

One of the more interesting of such recent designs is the James B. Lansing Sound Inc. model 075 Ring Radiator. This unit is unique in that its diaphragm is annular rather than circular, and drives an exponential horn whose throat is a circular slit rather than a round opening. The general configuration of the assembly can be understood by comparing the photo of the speaker with Fig. 1. The advantages of this departure from conventional design will be explained in the paragraphs to follow.

Conventional designs

An ordinary cone type tweeter becomes highly unpredictable in the upper range of audio frequencies. The main reason for ragged response is that even the stiffest cone material tends to break up and to vibrate in nodal patterns at wavelengths much less than the diameter of the cone. A 3-inch cone tweeter, therefore, would be expected to develop nodal breakup above about 6,000 cycles. In practice such breakup is all too evident. Since different portions of the cone are vibrating independently and in varying phase relationships with other portions, the acoustic output of the system rises and falls, depending on the combined effect of the various vibrating areas. These nodal patterns shift abruptly with changes in frequency, and the response curve of such a unit is quite ragged.

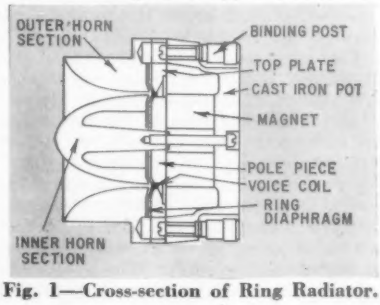


Fig. 1—Cross-section of Ring Radiator.

An equally serious difficulty is that cone breakup introduces harmonically unrelated "buzzes" and "sizzles" as well as a tendency to ring when excited by transient waveforms. The reasonably smooth range of cone tweeters is consequently limited to frequencies below 6,000 or 7,000 cycles.

Unfortunately, the design of a horn-loaded system is a rather delicate mat-

ter if response beyond 5,000 cycles is required. Since the area of the horn throat is considerably smaller than that of the diaphragm (to maintain a high degree of acoustic loading), some portions of the vibrating surface will be farther away from the throat than others. If this difference in path length approaches a half wavelength, cancellation of energy results. The only way to prevent this while maintaining a favorable acoustic load on the diaphragm is to include a carefully machined phasing plug to couple the diaphragm to the horn throat. Such a device (see Fig. 2) provides a number of exponentially expanding concentric paths, all of equal length, so that energy from various points on the diaphragm is combined in precise phase relationship.

A properly designed phasing plug solves the problem, but it is naturally expensive to fabricate. Several manufacturers have marketed substitutes of one kind or another but, so long as the sound-generating element is a circular diaphragm, these are effective only to the degree that they approach a true multiple, concentric-path phasing plug.

The electrostatic tweeter approaches the problem differently. By using a very large diaphragm, the acoustic load on the vibrating surface is kept high without the necessity of horn loading. Moreover, since the diaphragm is driven at a great many points on its surface, all portions of the moving assembly are kept in phase. However, the electrostatic unit in its present degree of development is not only costly and relatively inefficient, but some listeners have noticed a peculiar type of distortion which may be related to the overload characteristics of the unit.

This distortion takes the form of a disagreeable "crackle" on certain percussive sounds. In honesty it must be admitted that this extraneous noise may be a function of some other portion of the system which merely happens to be accentuated by the characteristics of the electrostatic design. The fact remains that it has been noticed by a sufficient number of critical listeners to make its existence reasonably well established. And it must be noted that most of those who object to this effect in electrostatic tweeters state that it is absent in certain other units of horn-loaded design. Whether any credence should be given to these reports or not, at least they establish that the favor enjoyed by electrostatic units at present is not unanimous.

Composition of the 075

Having briefly reviewed the problems encountered in various tweeter designs, let us go back to the JBL 075 and see how this unit meets the difficulties of reproducing the range above 3,000 cycles.

The diaphragm assembly used in the 075 consists of a shallow annular duraluminum trough, with a very light 1¾-inch voice coil attached to the apex of

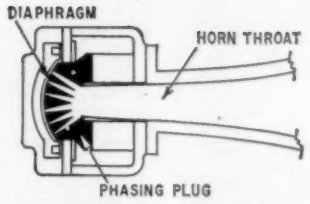


Fig. 2 — Cross-section of high-quality compression driver showing phasing plug.

the trough (see photo). The voice coil is edgewound aluminum ribbon. The V-shaped ring is driven at all points on its apex and the only major nodes of diaphragm breakup which can occur are those having a transverse relationship to the ribbon-shaped diaphragm. Since the distance from the apex to either clamping ring is much less than ¼ inch, it follows that diaphragm resonance or breakup cannot exist at frequencies less than 26,000 cycles.

Note that the problem of maintaining proper phase relationship at the horn throat also disappears. The maximum difference in path length to the horn throat from any two points on the diaphragm is on the order of 3/16 inch. This equals a half wavelength at about 34,000 cycles. For all practical purposes then, it is correct to say that energy from all points of the diaphragm arrives at the horn throat in exact phase relationship.

The horn itself consists of two concentric flared sections having a taper rate of about 2,500 cycles. The horn mouth is 3 inches in diameter, slightly greater than a wavelength at 2,500 cycles, resulting in a good acoustic match to free air above this frequency.

It should be emphasized that the rounded-off figures used in the preceding rough calculations are not those employed in the manufacture of the 075. Dimensions on the machined parts of the assembly are held to tolerances of ±.001 inch. Critical dimensions, such as the diameter of the horn sections at the throat, are held to tolerances of plus 0, minus .0005 inch.

High-frequency performance

JBL has requested that no frequency response graphs be published. The engineers point out that it is possible to plot significantly different curves on the same piece of equipment without deviating from accepted test procedure and that such published data can only confuse rather than assist the prospective buyer.

This may seem a noncompetitive attitude, but it has been respected in the preparation of this manuscript. It *can* be stated that the acoustic output of the 075 is smooth from about 2,500 cycles upward, with no abrupt peaks or dips. My own tests indicate that the unit is down less than 4 db at 15,000 cycles and, since no microphone can be trusted beyond this point, no effort was made to go higher in frequency. The published specifications for the transducer state, "Smooth response from 2,500 cycles to beyond audibility." Listening tests indicate that the 075 exceeds the limits of my own ears at any rate; a small amount of electrical power produces painful intensity at frequencies in the neighborhood of 18,000 cycles.

The rated impedance of the 075 is 16 ohms, and it may be used with any standard crossover network of this impedance. Crossover frequencies of 2,500 cycles or higher are recommended. The magnetic circuit of the 075 is extremely efficient and quite insensitive to changes in source impedance or in the damping factor.

Since the efficiency of the Ring Radiator is high, it will match the performance of even the most efficient bass and mid-range units. As a matter of fact, it is very easy to succumb to the temptation to "crank the control just a little wider" and accentuate extreme highs beyond the point of proper balance. When adjusted properly, however, it extends the upper frequency range smoothly and unobtrusively, with no audible trace of the shrillness or

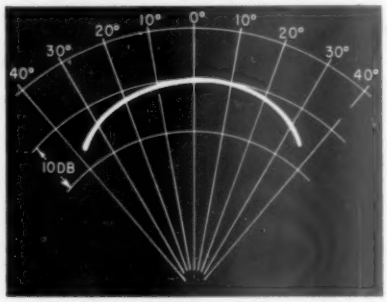


Fig. 3—Distribution pattern of 075 at 7,000 cycles.

buzzy characteristics of "bargain-counter" units.

In one respect the 075 may be considered *too* good, if such a thing is possible. Since its range extends beyond the limits of human hearing, it responds to ultrasonic oscillations such as those produced by some amplifiers under conditions of overloading or output tube unbalance. These ultrasonic bursts are inaudible themselves, but they cross-modulate other frequencies in the treble range and cause extremely annoying high-frequency distortion. Fortunately, such problems are seldom encountered when high-quality modern power amplifiers are used.

The ability of the 075 to respond accurately to frequencies at the upper limit of human hearing enables it to be used as a super-tweeter for existing two-way loudspeaker systems. JBL recommends that in this application the crossover be set at 7,000 cycles. By setting the upper crossover above any musical fundamental tone, the usual multiple-source problems of three-way systems are avoided. The 075, operating above 7 kc, reproduces only the range of overtones smoothly and unobtrusively. Its distribution pattern at 7,000 cycles is shown in Fig. 3. END

Using an oscilloscope, audio generator and vtvm, you can make power output, distortion and frequency-response checks on any high-fidelity amplifier

Checking HI-FI Amplifiers

A typical setup for making hi-fi amplifier tests.

By NORMAN H. CROWHURST *

CHECKING the performance of the amplifiers in a hi-fi system can be quite a problem. If a radio goes out of action, the local service dealer is equipped to troubleshoot, repair and, if necessary, realign the set. The same applies to TV receivers. Any service dealer has the necessary rf signal generator, oscilloscope and various other equipment needed to repair radio and television sets. But when a high-fidelity amplifier is brought in, there are problems.

To test a high-fidelity amplifier, you need an extremely high-quality audio oscillator, as well as a considerable amount of additional measuring equipment—distortion meter, IM meter, audio vtvm and millivoltmeter. Few service dealers (let alone individual hi-fi owners) have this kind of gear. In fact, there are few audio oscillators with distortion low enough to check the performance of a good amplifier against its specification. The harmonic content of the input signal from the oscillator is often larger than the maximum distortion the output signal should have. The usual professional procedure is to use filters to remove the harmonics from the input signal and use a distortion meter to find what the amplifier produces. This involves quite a lot of expensive and accurate equipment.

There is a simpler and cheaper approach to the problem. The essential components are some kind of audio oscillator that produces what looks like a sine wave (the waveform does not have to be *perfect*) and an oscilloscope. Some reasonably priced kits are available for both these units.

Measuring output power

To start, let's see how to measure the power output of an amplifier. We apply the oscillator's output to the amplifier through a resistive attenuator that provides about the right voltage for the amplifier input. The amplifier's output is connected to an appropriate resistance load—4, 8 or 16 ohms. If you are going to test it on the 16-ohm tap, you need a 16-ohm resistor large enough (wattage) to handle the full output of the amplifier. For example, six 100-ohm 10-watt resistors connected in parallel will produce a combined resistance of 16⅔ ohms with a dissipation of 60 watts, which is enough for almost any amplifiers.

Assume the amplifier is rated at 50 watts. The voltage across 16 ohms can be calculated from the formula $V = \sqrt{WR}$, which works out to about 28 volts rms output. If the amplifier requires a 1-volt input and the oscillator gives 10 volts, an attenuator consisting of a 1,000-ohm resistor in series with one of 8,200 ohms will allow a little margin to insure that the oscillator can be turned up far enough to produce full output from the amplifier. The hookup for this test is shown in Fig. 1.

By connecting the oscillator output to the scope's horizontal input and the amplifier output to the vertical input and the dummy load we have made, we should produce a straight-line trace on the screen when the oscillator is at a frequency of, say, 1,000 cycles (assuming there is no phase shift). Any departure from the straight line is an indication of distortion. Adjust the oscilloscope controls for horizontal and vertical deflection so a convenient line at about 45° and 2 or 3 inches long appears on the screen.

Turn up the oscillator's output control until distortion begins to show. If you have a reliable output meter or ac voltmeter, you can measure the voltage across the 16-ohm load and calculate the power at which distortion *begins* to show.

If you do not have an ac voltmeter handy, many modern scopes have a calibration provision which is quite reliable. The calibrator lets you adjust the scope so that a certain number of squares on the graphical transparency in front of the screen represents a certain voltage. Having calibrated the scope in this way, it is possible to measure the voltage accurately by counting the squares occupied *vertically* by the sloping line. If you have difficulty with this, you can always turn the horizontal control down so the sloping line becomes vertical. Then all you have to do is measure the length of the line against the graph markings.

How much distortion

If the voltage proves to be a little more than that required for the rated maximum output, say 30 volts for the nominal 50-watt amplifier, you can be satisfied that the amplifier is delivering its full rated output. The next question is how much harmonic distortion is in the output. You now set the voltage-measuring arrangement so you can tell when the voltage is exactly right for full output. For 50 watts this is 28 volts across 16 ohms. Adjust the oscillator until this voltage appears at the amplifier output. Then you can examine the trace more closely to determine ex-

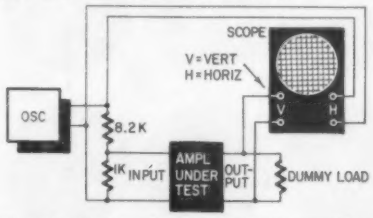


Fig. 1—Basic circuit used for making the tests described in this article.

* Author of *High-Fidelity Circuit Design, Understanding Hi-Fi Circuits, Audio Measurements* (Gernsback Library Nos. 56, 64, 73).

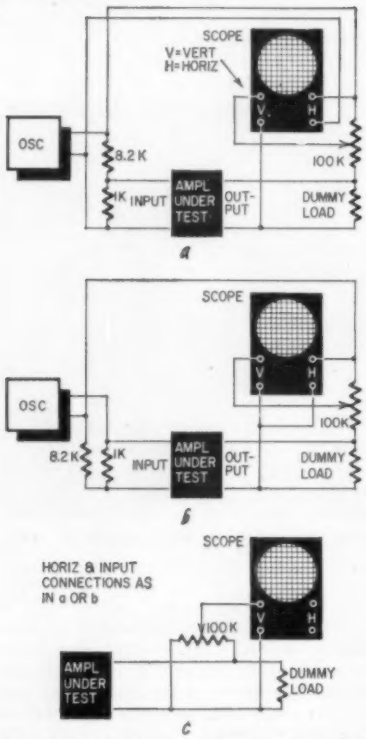


Fig. 2—Variations of the basic circuit used to balance out the fundamental when measuring harmonic distortion.

actly how much distortion there is.

If the amplifier is rated to produce full output with say 0.1% or even 0.5% distortion, this will probably be barely visible on the oscilloscope screen, using the simple direct trace like this. You have to amplify the distortion component without amplifying the fundamental. This can be done by balancing out the fundamental by some voltage taken from the input. The circuit arrangement is shown in Fig. 2. Use the arm of the potentiometer to find the point at which the fundamental balances out and produces a horizontal line. As you get nearer horizontal, turn up the scope's vertical gain control to get greater sensitivity.

The connection necessary to get a balance will vary according to whether or not the amplifier has a phase reversal —whether the output across the 16-ohm resistor is in or out of phase with the 1-volt input. Most modern amplifiers have one side of both input and output connected to ground, because of the feedback arrangement. Consequently we have to accept the amplifier as is and cannot alter the ground connection (at any rate not without serious risk of altering its performance).

If the amplifier has a phase reversal, the direct connection of Fig. 2-a can produce a satisfactory balance. If the amplifier has no phase reversal, we have to provide one, as shown in Fig. 2-b, before a balance can be achieved.

Having obtained a pretty close balance in this way, we need to go back and recalibrate for the output voltage with this new connection, so that we can determine how much distortion we have. To do this, transfer the pickoff point from the input end to the vertical deflection to ground. This is shown in Fig. 2-c. Check back to the full voltage output and readjust the scope so that this gives a certain specified vertical deflection with the connection of Fig. 2-c. Now go back to the balance condition of Fig. 2-a or -b and turn the gain, using the attenuator switch on the oscilloscope, 10 or 100 times. This will now mean that a vertical deflection of the same amount represents a peak distortion component of 10% or 1%, which is easily readable. The trace should appear, when correctly adjusted, as shown in Fig. 3-a. The peak-to-peak voltage can be calculated by the necessary adjustment to the oscilloscope. It can then be referred to as a fraction of the vertical deflection produced by the fundamental or main output.

This will show a peak reading of the distortion component which is quite different from that usually given by distortion-measuring equipment. *If the distortion is due to clipping*, as it is in most feedback amplifiers at a maximum power, *the table will give the relationship between the percentage distortion normally measured and the figures obtained by this method of measurement.*

Column A gives the peak-to-peak voltage obtained with the trace of Fig. 3-a as *percentage* of peak-to-peak output voltage; column B gives corresponding harmonic content as measured by the standard distortion-meter method.

A	B	A	B	A	B
20	23.6	3	1.32	0.5	.09
15	15	2.5	1.0	0.4	.0645
10	8	2	0.72	0.3	.0417
8	5.9	1.5	0.47	0.25	.032
6	3.75	1	0.255	0.2	.0228
5	2.87	0.8	0.182	0.15	.015
4	2.035	0.6	0.1185	0.1	.008

This method of measurement is actually much more sensitive than the usual way of measuring distortion, because distortion normally measured as 0.1% gives a reading of about 0.53% by this method.

If you are concerned only with making the distortion measurement at one frequency, adjust the frequency of the oscillator until the pattern shown in Fig. 3-a is obtained, by eliminating phase shift. This will occur somewhere in the middle of the frequency band, probably between 600 and 2,000 cycles. In fact, variation over this frequency range will not cause serious departure from the pattern. It will just make the trace separate as shown in Fig. 3-b, because of a slight phase shift.

But if you want to measure power at low or high frequencies, the phase shifts will be too great for the pattern to mean anything at all. Then the only way is to insert a phase-shift network in the input, so the phase of the input signal can be adjusted to compensate for the phase in the amplifier. This can be done with the network shown in Fig. 4. The values of the capacitors in this network depend on the frequency at which this measurement is made. It is simplest to make up the little network for some particular frequency, say 50 or 10,000 cycles, and just make the measurement at this frequency, rather than try to make continuous measurements at various frequencies. However, the phase-shift network will allow a slight variation of frequency and still give the possibility of obtaining a satisfactory pattern.

Fig. 3-c shows the kind of pattern displayed when the phase shift is seriously off and the balance is adjusted for the nearest elimination of the fundamental. The pattern is extremely difficult to interpret, so the only way to proceed now is to use the phase-shifting network to get back to the pattern of Fig. 3-a or almost to it. Then go back over the arrangement and check the voltages at different points. Readjust the input resistance values, if necessary, to get sufficient output to drive the amplifier to the full output level and recalibrate the scope with the circuit used. Then a certain vertical deflection, with the potentiometer for vertical deflection connected as in Fig. 2-c, represents a known voltage. Go through the procedure just mentioned to find out how much the harmonic vertical deflection represents.

Frequency response

Another thing you will want to measure is the amplifier's frequency response. This method is particularly convenient for measuring frequency

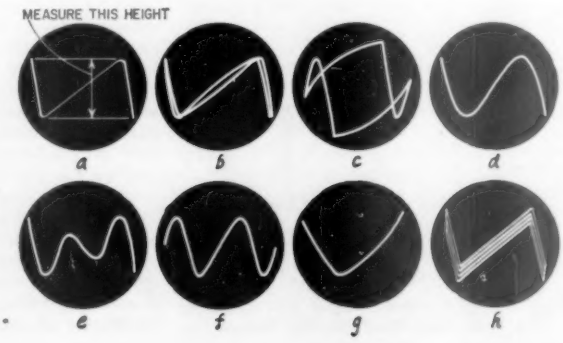


Fig. 3—Oscilloscope traces you are likely to run into when making distortion measurements.

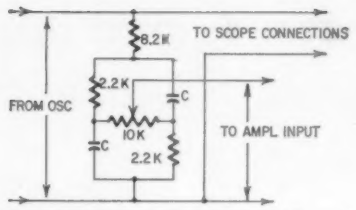


Fig. 4—To overcome phase-shift problems when making measurements at low and high frequencies, interpose this circuit at the amplifier's input. Capacitors C should be chosen to have a reactance of about 2,000 ohms at the frequency used for the check.

response because it can be determined by the *angle* of the sloping line. Adjust the vertical and horizontal gain control at 1,000 cycles, using the circuit of Fig. 1, so that the sloping line appears at 45°—easly determined by seeing that it cuts diagonally across the squared pattern on the transparency.

Now you can sweep the oscillator up and down in frequency and watch the slope of the line. If the *length* of the line alters, the output from the oscillator is not constant. This does not matter, because you are not concerned with having the oscillator output equal to the same overall length of line, but the *slope* of the line represents the amount of gain in the amplifier.

If you want to measure frequency response to within say 0.1 db, the direct method of Fig. 1 will be very difficult to read. But sensitivity can be increased by the method used for harmonic measurement. If you step up the vertical gain by 10 to 1 and readjust, using the circuit of Fig. 2-a or -b, to get a 45° line, variation in the vertical deflection of 10%, or one-tenth of the deflection each way, is easy to see and measure and represents a change of gain of 1%, or 0.8 db. Stepping up the gain by 100 to 1 (if the line remains reasonably straight when readjusted to 45°) gives even greater sensitivity. A 10% change in height over width will represent an .08-db change in gain at that frequency.

Measuring this way, you must not use any phase-shifting components, because these will produce their own frequency response. At the end frequencies, the 45° line will open out into an ellipse even more rapidly when the sensitivity is stepped up. But the thing to measure is the ratio of the height to width. If necessary, horizontal deflection can be momentarily deactivated by turning the function switch to measure height on a vertical straight line.

Before making measurements with an oscilloscope at extreme frequencies, make sure that the scope amplifiers have a satisfactory frequency response, or at least that the vertical and horizontal amplifiers are *consistent*. Connect both vertical and horizontal terminals of the oscilloscope to the oscillator output and sweep the oscillator up and down in frequency to see that the slope of the line on the oscilloscope stays constant and that it does not open into an ellipse. If this condition is satisfied, it does not necessarily mean that the amplifiers do not produce any phase shift or attenuation with the different frequencies used. It *does* mean that both produce identical characteristics. Many modern scopes, even the low-price variety, achieve this because they use identical deflection amplifiers for vertical and horizontal amplifiers. If both produce the *same* phase shift and attenuation at higher or lower frequencies, the actual amount will not matter because the results obtained will be the same.

This is one advantage of this method of measurement. We do not have to have *perfect* oscilloscope amplifiers, merely *consistent* ones. Nor do we have to have a perfect oscillator. If the oscillator has as much as 5% distortion, it is still possible to use it to check and determine that an amplifier has no more than, say 0.1% distortion. We are not measuring the absolute amount of harmonic in the output but comparing the output against the input.

Low-level distortion

Another important thing to measure is distortion at lower levels. The same method can be used, but the pattern obtained is different. This can serve as a useful clue to the kind of distortion present. Most distortion in modern amplifiers is due to the curvature in the output tubes. Feedback, of course, reduces distortion but, whatever there is, the feedback will reduce just that particular distortion. This method of measurement enables the amplifier to be adjusted, if necessary, to achieve optimum performance.

Figs. 3-d, -e and -f show the kinds of displays that appear on the balanced condition at lower levels with different kinds of curvature in the amplifier. The best kind with a push-pull amplifier is that which indicates only third-harmonic distortion, shown by Fig. 3-d. Figs. 3-e and -f indicate components of higher order distortion which can be due to incorrect loading of the output stage (which should not occur if you have the right loading resistance) or to incorrect biasing.

If the two output tubes are not properly matched, second- and even-order distortion will appear, as shown by Fig. 3-g. If there is a way to adjust the bias of each output tube separately, this may be rectified by adjusting the bias of the individual tubes. Otherwise the best remedy is to use a matched pair of output tubes. If the higher-order odd harmonics appear, as in Figs. 3-e and -f, the best plan is to adjust the bias of both tubes so that these disappear, producing a pattern more like Fig. 3-d.

After adjusting the bias, always check the dc voltages on the tubes to make sure that you do not have excessive dissipation that may shorten their life. For example, if the bias should be, say, 35 volts, and you find you have dropped this to 25 volts to get rid of the distortion, the tubes will draw excessive current.

The foregoing test will show whether the amplifier performs *to specification*, which means a resistance output load is used. This is what an engineer will usually check (but with more elaborate equipment). It is a good idea to make similar performance checks with the speaker connected in place of the resistance load. (Occasionally, even an engineer will listen to the amplifier on a speaker as well!) The results obtained have no definite meaning in watts output and frequency response (which is why engineers seldom bother to make such a check) but it can give a good idea as to whether the amplifier still behaves itself with a speaker load connected. You will be able to see whether something drastically different takes place.

Hum problems

The oscilloscope can also be a useful tool in tracking down other undesirable features such as hum in an amplifier. If hum is present, you will find that the patterns, when fundamental is balanced and you turn the gain up to look at the harmonics, will be dancing vertically or they will be a multiple trace, as shown by Fig. 3-h.

In this case the best plan is to remove the oscillator input and switch the scope's horizontal deflection to the position which feeds it 60 cycles, usually marked line. Then, with the vertical gain turned well up, you can examine the amplifier output against this horizontal 60 cycles to find out what kind of hum is present. If it is 60-cycle hum, the trace will either be a sloping line or an ellipse, as shown by Figs. 5-a or -b. If it is 120-cycle hum, usually

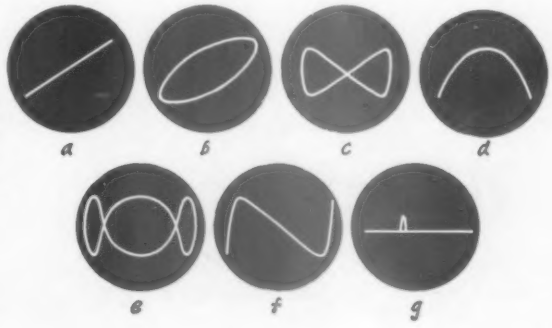


Fig. 5—Some typical traces associated with hum detection. The scope's horizontal deflection circuit is operated at power-line frequency.

from an inadequately smoothed high-voltage supply, the trace will be a distorted figure-8 or a curved line as in Fig. 5-c or -d.

Occasionally a pattern similar to that of Fig. 5-e or -f will appear, indicating that the frequency of the hum output is 180 cycles or a third harmonic of the line frequency. This is usually due to electromagnetic hum radiated from a power transformer. Maybe the input circuits pass too close to the power transformer or perhaps you have an input connection that is carried too close around the power transformer.

Sometimes you will find that the hum appears to be just a nick on the trace, as in Fig. 5-g. This indicates that the hum in the output is due to a sharp pulse that occurs just once (or maybe twice) every cycle of the 60-cycle waveform. This is usually due to the high-current pulse that passes through the rectifier in a capacitor input high-voltage system. It often gets into the amplifier audio circuit through the heater supply, because the high-voltage and heater windings are both on the same transformer. Check that the heater winding is properly grounded. If not, provide a satisfactory ground, if necessary through a center-tapped resistance.

The same checks described for a power amplifier can also be applied to a preamp. As well as checking that the frequency response is flat in the flat position, an approximate check of the frequency response through equalization and tone-control sections can be carried out, watching the vertical deflection on the scope to see whether it varies as it should.

However, *slight* deterioration in the performance of a preamp is much less common than in a power amplifier. The usual things that happen in a preamp cause more serious and obvious deterioration; the low-level signals which it handles are so much more easily upset. If a component in these low-level circuits becomes defective, the result is usually very noticeable and tracing the fault is much easier than in the higher-level stages of a power amplifier. END

"And I want a color bar generator, a field-strength meter . . . ."

Feedback Tone Control

By A. V. J. MARTIN

High-fidelity tone controls through feedback

THIS elaborate tone control using a separate feedback chain is found in some Marquett French receivers. The theoretical circuit is shown in Fig. 1. The af voltage from the anode of the preamp is applied to the grid of the power amplifier through a divider made of two 470,000-ohm resistors. The grid thus receives only half of the af voltage. However, a low-value capacitor is connected in parallel with the first 470,000-ohm resistor, effectively short-circuiting it at high frequencies and producing an important treble boost.

This arrangement is completed by a feedback chain around the power stage. A four-position switch modifies the effect of feedback. To make things clearer, the simplified diagrams Figs. 2-a, -b, -c, -d, show what is the actual circuit for positions 1 to 4 of the switch.

In position 1 (Fig. 2-a), the feedback chain is a simple 2.2-megohm resistor, giving an overall feedback ratio of the order of 10%. The high frequencies are boosted by the coupling cidcuit so that this is a treble-boost circuit.

In position 2 (Fig. 2-b), a series R–C combination appears in the feedback path. It reduces by approximately 50% the feedback at low frequencies, which becomes 5%. At medium frequencies, you obtain the full 10% feedback. At high frequencies, there is the boost due to the coupling circuit. This is then a bass- and treble-boost circuit.

In position 3 (Fig. 2-c), the circuit is identical with Fig. 2-b, except for the fact that the shunt capacitor in the coupling circuit now has the lower value of 250 $\mu\mu$f. The treble boost appears at higher frequencies. The bass and medium frequencies behave as in Fig. 2-b. This then is again a bass-and-treble-boost position, the treble boost coming into play for the higher frequencies.

In position 4 (Fig. 2-d), the circuit differs from Fig. 2-c by the connection of a 50-$\mu\mu$f capacitor between plate and grid of the power stage. This causes a strong feedback at high frequencies, but does not modify the behavior of the circuit for bass and medium frequencies. This is then a bass-boost–treble-cut circuit.

The simplified response curves included in the diagrams give a rough idea of the effects of this clever circuitry. END

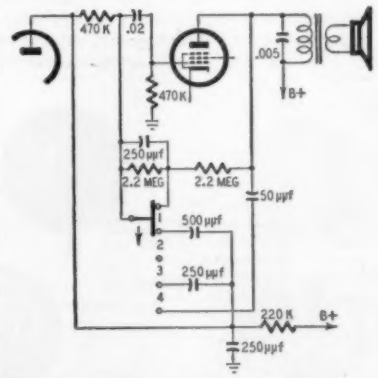


Fig. 1—Circuit of the 4-position feedback tone-control circuit.

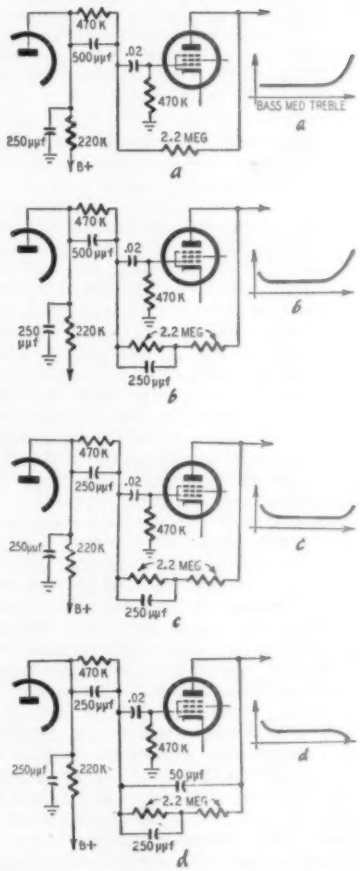
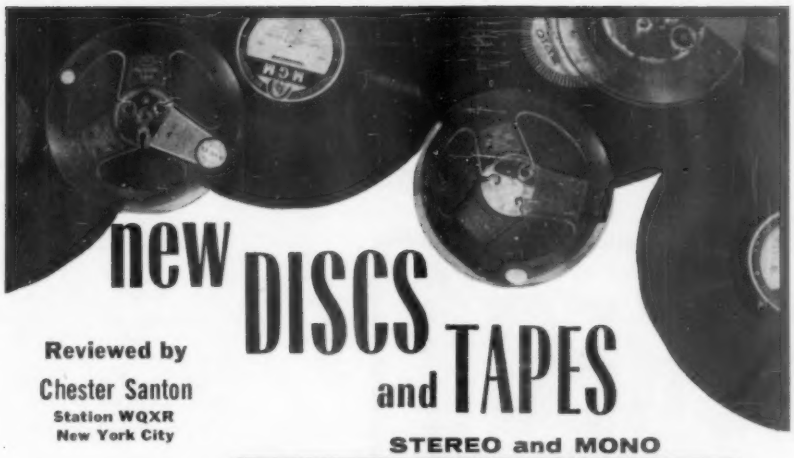


Fig. 2 — Feedback circuits for each switch position of Fig. 1 and their effect on frequency response: a—treble boost; b—bass and treble boost; c—same as b, but treble boost starts at higher frequency; d—bass boost and treble cut.



new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

REVIEWERS of stereo records, in company with audiophiles in all walks of life, found improved stereo pickups at the 1958 New York High Fidelity Music Show. Critics now have less excuse to complain about variables in cartridges when evaluating stereo discs. Before the show, one could encounter drastic differences in the sound of a given record by switching pickups. For example, RCA stereo discs sounded dull and thin using cartridge A but sparkling and full on cartridge B. London FFSS discs, on the other hand, exhibited peaked treble with cartridge B and reasonably linear response with A. At present not all stereo records conform to the RIAA characteristic. The cartridge half of the problem has been reduced with the introduction of stereo pickups of more uniform response.

Also unveiled at the show were 3.75-ips four-track stereo tapes on open reels that approached for the first time the performance of 7.5-ips tapes. I noticed that top-notch playback equipment was used to achieve this, and that material played was pop stuff, narrow in dynamic range.

HOLST: *The Planets*
Leopold Stokowski conducting Los Angeles Philharmonic Orchestra
Capitol Stereo Tape ZF-75
(7-inch; playing time, 46 min. $14.95)

One of the very few firms still releasing classical music on stereo tapes at 7.5 ips, Capitol sweeps the field as well as the skies with this one. A good single-channel record, this tape offers sound impossible to find on today's stereo records. The movement describing the planet Mars drives home the point. Percussion of tremendous weight underlines the snarl of the brass section. A particularly useful application of stereo is found in the depiction of the final planet, Neptune the Mystic. The wordless melody of the women's chorus is now set off in space as originally called for by the composer. A new experience.

Virtuoso
Roger Wagner Chorale
Capitol Stereo Tape ZF-84
(7-inch; playing time, 37 min. $14.95)

A recent Capitol bestseller on monophonic disc, this highly varied collection for mixed chorus really hits its stride in stereo. The seven selections range from the *Hallelujah Chorus* of Handel's *Messiah* to *Polly Wolly Doodle*. Di Lasso's *Echo Song* is ideal stereo material with its solo quartet echoing off mike the phrases of the main group. This tape, which includes some use of an echo chamber, reaches a stunning climax in the excerpt from *Catulli Carmina*. In this work Carl Orff, perhaps the most famous German composer today, backs up the chorus with five pianos and a huge percussion battery. A fine time is had by all.

Sweet Moods of Jazz in Stereo
Soundcraft Bonus Tape
(7-inch; playing time, 28 min.)

Purchasers of the new Soundcraft Premium Pack pay a dollar more than the price of two reels of tape. The tape on one reel in this pack is blank. The other reel contains this recording in intimate stereo that features such famous jazz musicians as Coleman Hawkins, Earl Warren, Henry "Red" Allen, "Chubby" Jackson and George Wettling. Excellent low bass response mellows a highly professional handling of seven staple songs. Larry Clinton, in his supervision of the recording session, achieved maximum separation in the stereo placement with ultra-close miking.

The Trembling of a Leaf
Pianist Ray Hartley with David Terry Orchestra
RCA-Victor Stereo Tape APS-186
(7-inch; playing time, 16 min. $4.95)

Although quiet on the classical tape front, RCA continues to release pop material on two-track stereo tape. Five tasteful background tunes receive above average performance here. In the title tune and the *Sound of the Sea*, the young Australian pianist offers sensitive tonal impressions at a carefully centered piano. The sound more than meets the requirements of the music.

PROKOFIEFF: *Symphony No. 5 in B Flat*
Eugene Ormandy conducting Philadelphia Orchestra
Columbia Stereo Record MS-6004

Columbia's first stereo discs display cleaner-than-average sound and a recording level somewhat lower in intensity than that found on on other labels. The Philadelphians' recent monophonic version of the Prokofieff *Fifth* contains exciting sound but is no match for this stereophonic release. Now each famed choir of the orchestra can be distinguished as it lends its special skills to Prokofieff's most ebullient symphony. Stereo discs call for top instrumentalists whose work can withstand detailed analysis in two-channel sound. The Philadelphia orchestra, as always, brilliantly meets the test.

RIMSKY-KORSAKOV: *Scheherazade*
Mario Rossi conducting Orchestra of Vienna State Opera
Vanguard Stereo Record SRV-103 SD

If I review this work a few more times, I may learn to spell it without looking at the album jacket. Vanguard again makes this music newsworthy on a special demonstration stereo record priced at $2.98. As in the case of monophonic records in their demonstration series, the sound matches that of their full-price stereo discs. The stereo separation and directionality hold their own with other labels' versions of this tonal tapestry.

BARBER: *Vanessa*
Dimitri Mitropoulos conducting Metropolitan Opera Cast, Orchestra and Chorus
RCA Victor Stereo Record LSC-6138

Following its world première in January, Samuel Barber's first operatic work was hailed as the best American opera ever presented at the Met. RCA Victor has selected this Metropolitan production as its first opera on stereo disc. Having heard samples of operetta recordings in stereo on other labels, I opened the dual channels of this three-record album with considerable anticipation. I was surprised to discover that, instead of moving about on an imaginary stage, the *Vanessa* cast remained stationary throughout most of the performance. The singers have been recorded in the center of the stereo area with the sound of the orchestra surrounding them on all sides. Miking is closer than that used during the Met broadcasts. The voice levels do not vary as they often do on the air. The sound is crisp and fresh, befitting a new and important venture in American opera.

Let's Dance
David Carroll and His Orchestra
Mercury Stereo Disc SR-60001

This recording represents some of the efforts being made to satisfy both schools of thought on the question of separation of sound sources in stereo. David Carroll, who also serves as Mercury's A and R director, strives for the solid wall of sound between speakers during the ensemble work of the orchestra. Then, to placate those who look for placement of individual instruments in one loudspeaker at a time, he mikes the soloists at the outer edges of the so-called wall of sound. Such liberties, undesirable in stereo recording of classical music, point the way to a solution of the separation controversy.

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwse indicated.

The Organ
E. Power Biggs
Columbia DL-5288

A lavish yet highly informative gift item sure to please any organ fan. Enclosed in a 39-page volume with comprehensive essays and illustrations, this record sums up in sound the recording efforts of organist E. Power Biggs during 5 years of touring Europe. Dozens of famous classical organs of Holland, England, Germany, France, Austria, Spain, Portugal, Iceland and the Scandinavian countries are described and played by Mr. Biggs. The sound is magnificient. A first-rate system will reveal fascinating differences during the tonal comparisons of organs recorded with the same microphone and tape recorder. Substantially the same mike placement was used in all instances. By a wide margin the finest release of its type.

SCHUBERT: *Octet in F Major*
Berlin Philharmonic Chamber Music Ensemble
Capitol-EMI G-7112

With the introduction of this new label featuring artists of its parent company, Electric and Musical Industries of England, Capitol now offers three classical catalogs. A sampling of several discs in the first release reveals a recording characteristic unlike that of the Capitol and Angel curves. I get best results at a turnover higher than that called for in the RIAA setting. With the bass filled out, this is a beautiful record of Schubert's ingratiating chamber work for woodwinds, strings and horn.

The Virtuoso Oboe
Andre Lardrot, Oboist
Felix Prohaska conducting Chamber Orchestra of Vienna State Opera
Vanguard VRS-1025

The four oboe concertos on this record reflect the easygoing atmosphere of 18th-century music making. Exceptional presence in the pickup of the smoothly played solo instrument.

TCHAIKOVSKY: *Capriccio Italien*
George Szell Conducting Cleveland Orchestra
Epic LC-3483

Normally assigned heavier classical fare by Columbia and Epic, Szell demonstrates here the value of disciplined, straightforward musicianship. He sets in a new light the *Capriccio Italien*, Rimsky-Korsakov's *Capriccio Espagnol* and *Dances of the Polovtsi* from Borodin's *Prince Igor*. There is a natural richness in the sound.

Music of Leroy Anderson, Vol. 2
Frederick Fennell Conducting Eastman-Rochester Pops Orchestra
Mercury MG-50043

With this second album, Mercury now has on the market its own version of Leroy Anderson's most sought-after tunes. Luckily, his transparent scoring permits placement of six selections on each side of the record without undue sacrifice of dynamic range or frequency response. A good buy. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

AUDIO—HIGH FIDELITY

READY FOR STEREO?

Part III—The concluding section of this series deals with stereo discs, cartridges and the problems they present

By DONALD C. HOEFLER

THE commercial stereo disc is scarcely a year old, yet this bawling youngster has thrown the hi-fi industry into a state of consternation and the audiophile into a state of confusion.

The trouble began with an initial misconception which still is not completely dispelled. Originally this new record was thought perfectly compatible—that it could be played monophonically on existing equipment as well as stereophonically with an additional channel.

But this is true *only* if you use a stereo cartridge. While a standard pickup will track a stereo groove and reproduce sound, it will also damage that groove severely. To understand just why this is so, we must consider the differences between stereo and monaural record grooves.

Stylus movement

A phono pickup generates an electrical signal because of *displacement* of the groove from a center path. This reproducing stylus moves to follow the groove and this movement is transmitted to the cartridge's element producing a voltage output.

In the conventional monophonic record the displacement is *lateral*, as shown in Fig. 1-a. The groove moves from side to side about the center point. Groove depth remains constant.

Another monophonic system, sometimes used for broadcast transcriptions, is *vertical* (see Fig. 1-b). Now the groove moves up and down about a center point, and its depth varies.

In Fig. 1-c the displacement force comes from an angle of 45° with respect to the record face. This time, the left wall of the groove is displaced diagonally about its rest point, but the right wall is unaffected, except for having its length varied.

Similarly, if the displacement is driven from 45° in the other direction, as in Fig. 1-d, the right wall is displaced while the left wall remains in line. The modern stereo disc uses a combination of the movements shown in Figs. 1-c and 1-d, and has been dubbed the 45/45 system.

In practice, the left-channel signal is applied as in Fig. 1-c and the right as in Fig. 1-d. Two motors are used in the cutter and two transducing elements in the cartridge.

It is interesting to note that when the two signals are equally intense and in phase, the resultant groove motion is vertical. When the signals are exactly out of phase, the groove is displaced laterally.

As a practical matter, the stereo reproducing stylus must be able to follow any of the four types of motion shown in Fig 1. The groove bottom may then fall anywhere within the shaded square shown in Fig. 1-e. But for the standard monophonic pickup, this is too much.

The monaural cartridge is purposely designed to be unresponsive to vertical motion. With a minimum of output resulting from such motion, it effectively filters out vertical turntable rumble and other such spurious signals.

The monaural cartridge's system is also made much stiffer in the vertical direction than in the horizontal plane. This makes for better tracking of a lateral groove, but it only makes for destruction of the 45/45 stereo groove.

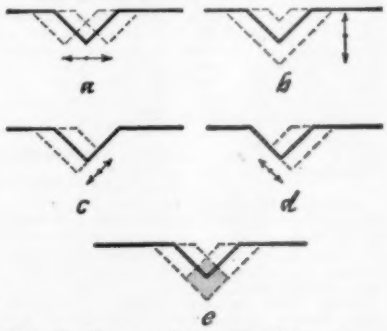


Fig. 1—Some of the possible groove displacements in phonograph records: a — lateral; b — vertical; c, d & e — 45/45 stereo.

The moving elements in the stereo cartridge must be free to respond to displacement anywhere in the shaded area of Fig. 1-e. This is possible only if the mechanical linkages between stylus and generators are equally compliant in both directions.

The generating elements may be either piezo or magnetic. Both crystal and ceramic pickups are available in the piezo types, and in the magnetic group are moving-coil, moving-magnet and variable-reluctance types.

Last month we advised that one of the first steps in a stereo conversion should be replacement of the cartridge. This is true *only* if you are definitely committed to the idea of going stereo, and should not be taken to mean that a stero cartridge is superior to the lateral types for monophonic records. The stereo cartridge will play both types of records, while the mono cartridge cannot track stereo records without damaging them. But on the other hand, the standard cartridge is still better for standard records. Of course, for best results, two arms and pickups, one for mono and one for stereo, can't be beat.

Not only must the stylus in a stereo groove be able to move to more places, it also has to move more hardware around with it. Stereo cartridges have two elements instead of one, and the increased mechanical mass lowers the resonance, perhaps even into the audio region. While the listener may not be concerned with the heartbreaking struggles of the pickup designers over the past year and a half, it is important to realize that there is no need to place an additional strain on your pocketbook by replacing a perfectly good pickup, unless you are definitely com-

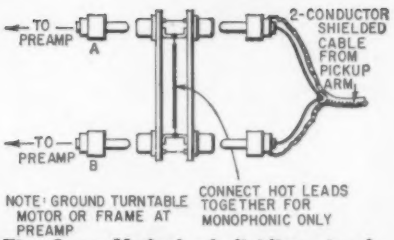

TO PREAMP A
2-CONDUCTOR SHIELDED CABLE FROM PICKUP ARM
TO PREAMP B
NOTE: GROUND TURNTABLE MOTOR OR FRAME AT PREAMP
CONNECT HOT LEADS TOGETHER FOR MONOPHONIC ONLY

Fig. 2 — Method of dividing signals from pickup-arm cable before connecting to stereo preamps. Jumper permits combining signals for monophonic reproduction.

mitted to following through with a complete stereo system.

Turntable rumble

Another problem which has caused many sleepless nights is turntable rumble. Many otherwise excellent tables have exhibited excessive vertical rumble when used with a stereo cartridge. The standard lateral pickup effectively damps out the effect of these vibrations, but the stereo units show it up for all it's worth.

Usually, the motorboard must be more carefully isolated from the floor and from the speaker cabinets, using additional soft springs or foam-rubber pads. This problem may also be the explanation for the increased number of belt-driven turntables on the market, a type which until recently had not been very popular.

Stereo in monaural system

The outputs from each of the two stereo-cartridge elements are usually unbalanced. Each signal is ac, and one output lead is grounded. In some units the two ground leads are tied together internally and come out to a common terminal. In others, they come out to separate terminals, although they may be connected internally anyway. This is the reason why some cartridges have four terminals while others have only three.

When using a stereo cartridge in a monophonic system to play a stereo disc, the existing phono cable in the pickup arm may be used. The ground terminal(s) of the cartridge are connected to the ground or braid of the cable, while the two remaining pickup terminals are paralleled and connected to the cable's hot lead.

While this puts the two generator signals in phase electrically, there may still be some audio phase distortion. Nearly any sound produced in the studio will be recorded in varying degrees on both channels. This is right and proper, if you intend to avoid "pingpong" and other extreme effects used by overzealous recordists.

But there is a difference in arrival times of the sounds reaching the two microphone recording channels. And the phase relationship between the two resulting signals depends on the frequency of the sounds and the relative distance of the microphones from the source.

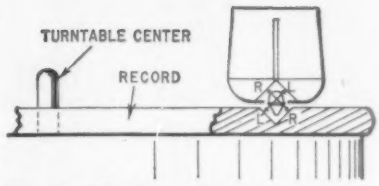


Fig. 3—The left pickup element handles the right channel, while the right element handles the left channel.

As explained in Part I of this series, when this phenomenon occurs in life, your ears allow for it. In fact, this is one of the ways we determine the direction of a sound source. But an electronic amplifier is not as clever as the human brain, so it simply combines all components of the complex signal fed into it.

If the signals should happen to be out of phase at a given instant, the sound will be unnaturally attenuated; if they should add together, there may be some unexpected peaks. This is one more reason for using a stereo pickup with a monophonic system only as a stop-gap at best.

All present stereo cartridges are designed for standard mountings and may be installed in most existing pickup arms. When both outputs are used for stereo, simply install a second length of shielded or twisted phono cable in the arm or even better, replace the existing wiring with a new length of two-conductor cable. Then the two channels are split up, using a jack-plug arrangement mounted on the turntable chassis, as shown in Fig. 2.

Which channel is which

Designating the channels as left and right is done with respect to the observer. The left side of the orchestra as you face it is recorded on the left channel and reproduced from the left speaker.

As for the disc, left-channel information is engraved on the left or inside groove wall. The right channel is on the right or outside wall. Since each pickup element is diagonally opposite the groove wall affecting it, the left element responds to the right channel, while the right element picks up the left channel. Although confusing when put into words, Fig. 3 makes this idea quite clear. END

NEXT MONTH

SIGNAL-LEVEL COMPARATOR

A quick way to check your amplifier's gain and frequency response. Also operates as an attenuator or voltage divider.

By J. E. Pugh, Jr.

BUILD AN AUDIO EAR

A simple and ingenious induction phone unit permits the children to listen to TV with the volume all the way down, may be used as a paging unit or as a mystifier for home entertainment.

By Edwin Bohr

PORTABLE EQUIPMENT IN COLOR TV SERVICING

Red and Fuzzball come back with penetrating comment and valuable information on some of the less-publicized aspects of color TV service.

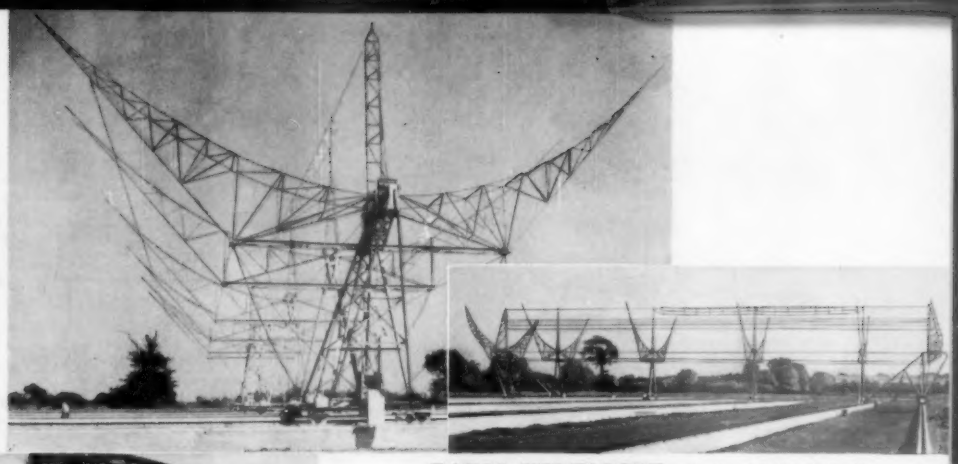
By Robert Middleton

SIMPLE SUPER TIME BASE

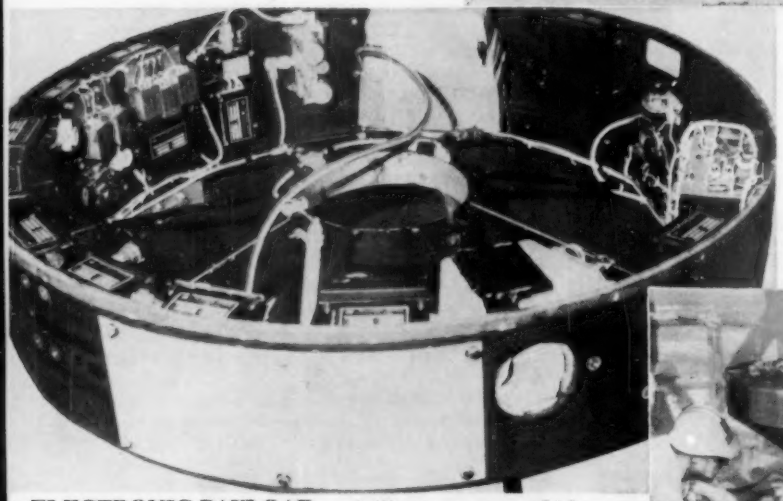
Promised for this issue, this article was delayed by an unfortunate fire in our draftsman's studio. Copies of the drawings have been received, and we hope to print it next month.

By Tom Jaski

what's new?

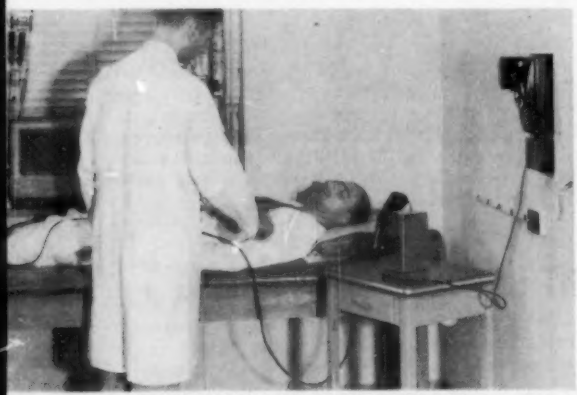


RADIO TELESCOPE at the Mullard Radio Astronomy Observatory of England's Cambridge University will use galvanized-iron wires stretched across tubular steel frames in place of the usual paraboloid reflectors. Shown here during construction before the installation of the 320 reflector wires, the reflectors can move along 1,000 feet of railroad tracks, and can rotate about the east–west axis. Two small antennas can be positioned along the giant reflector to cover the required area. Resolution is equivalent to that of two antennas each 800 x 500 feet.

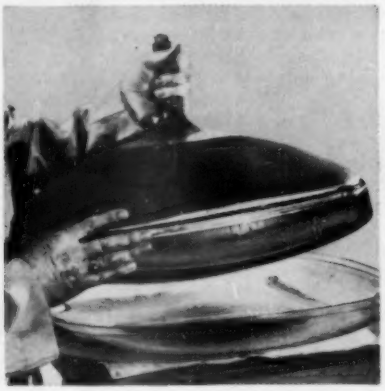


Wide World Photos

ELECTRONIC PAYLOAD of Pioneer space vehicle, which climbed more than 79,000 miles. Among the electronic devices were instruments to measure magnetic fields of the earth and moon, the number of micrometeorites encountered in flight, radiation intensity, internal temperature, and an infrared scanner to view the far side of the moon, plus telemeter transmitting equipment to convey the data to receiving stations. The complete instrument package weighed only 25 pounds. Smaller photo shows position of electronic package as technicians adjust small vernier rockets.



ELECTROCARDIOGRAMS BY PHONE are possible with this 5-pound transistor device developed by Dr. E. Grey Dimond of the University of Kansas Medical Center. Standard electrocardiograph leads are attached to the patient. At the receiving end of the telephone line, a modified unit is attached to any standard electrocardiograph machine. No attachment to the telephone is necessary. The transmitter uses a frequency modulated tone and a push-pull dc amplifier. Using a more complex system, two Kansas City, Mo., physicians recently diagnosed heart conditions of three patients in Bethesda, Md., through a long-distance circuit which relayed not only electrocardiograms and heart sounds, but electronically coded signals for pulse respiratory rates and volume.



SAFETY GLASS becomes an integral part of the picture tube in a new process developed by Corning Glass Works, manufacturer of glass envelopes for picture tubes. The new tube has a second contoured glass panel laminated permanently to the original bulb. A clear liquid plastic is cast between the permanent safety glass and the picture-tube face. Insert shows the "twin-panel" tube after curing. Finger indicates how the glass skirt fits completely around the faceplate. A different version of the bonded safety glass was introduced recently by Pittsburgh Plate Glass Co. (RADIO-ELECTRONICS, October, 1958, page 6).

electronics brings LIGHT to the BLIND

Experiments show that electronics may one day restore sight to the blind

By JOHN C. BUTTON, JR., M.D.

THE problem of restoring sight by artificial means has intrigued mankind since the dawn of time. But although literature abounds with examples of achieving this objective by miraculous processes, it took modern electronics actually to turn night into day for the sightless.

The dramatic event first occurred in a Los Angeles, Calif., hospital's operating room on the morning of Oct. 29, 1957. Tiny holes were drilled in the skull of a volunteer patient. Wires finer than human hairs were placed in the holes. Then came the real heroes—two home-made square-wave generators and a pair of cadmium-sulfide photocells. The result brought jubilation to a tiny knot of doctors and nurses gathered in the room. For a totally blind person *saw light*—through the magic of electronics—for the first time in medical history.

Problems to overcome

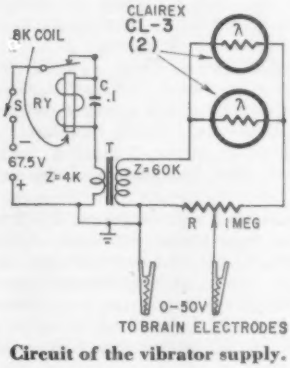
It sounds simple, but this simplicity is deceptive. Actually, the process of duplicating vision electronically is so staggeringly complex that few scientists, even after my initial experiments, thought it possible. Many are still skeptical. "Yes, you have obtained light," they protest, "but you will never get true vision."

Consider the most obvious difficulty. Each retina, in back of the eyeball, contains over one million individual light-sensitive nerve cells. Each cell is connected to its own nerve fiber. Collectively, these nerve fibers traverse the brain from front to back in two bundles known as optic nerves." In recesses deep within the brain the optic nerves pass through "relay stations" where they are joined by other nerves providing interpretative functions. Here, indeed, are point-for-point mosaics of such intricacy that scientists have yet to explore them fully. These visual "cables" terminate in the very back of the brain, in an area half the size of a lemon, known as the visual cortex. It is here that consciousness of vision actually occurs, and it is this area that was "tapped" by the author and his associate, Dr. Tracy J. Putnam (a famed brain surgeon, now chief of neurosurgery, Cedars of Lebanon Hospital, Los Angeles, Calif.).

The logic behind selecting this spot is simple. First, the area is readily accessible from a surgical standpoint. More important, it is usually intact in blind persons. Nearly all blindness is caused by disease or accidents affecting either the eyes themselves or the sight pathways *forward* of the visual cortex. By "plugging" directly into the visual cortex, all such parts are bypassed. Vision could then be possible—at least theoretically—even in a person *without eyes.*

The first step was to find a willing volunteer patient. Fortunately I had under my care a woman of 36, who had been totally blind for eighteen years and who was willing to undergo the tests.

Two major problems now arose. First, would electrical stimulation of the visual cortex actually produce flashes of light in our patient? It was common knowledge that it would in persons with normal sight. The phenomenon had been demonstrated on numerous occasions during brain-mapping studies at research centers in the United States and Canada. But no such tests had been performed on truly blind individuals, who conceivably might not react in so-called normal fashion.



Circuit of the vibrator supply.

Furthermore, most scientists felt that sight cells in the brain of a person who had been blind for any length of time had probably atrophied or dried up from extended lack of use. This happens with most bodily functions if they remain unused. Why, asked the scientists, should the sight cells be the only major exception to the rule?

A second basic problem faced us. If electrical stimulation of the brain produced flashes of light, what then? How could such flashes be correlated with outside illumination to provide a practical measure of sight?

We answered the second question first. The flashes of light (*if* they occurred) would be induced by electricity of a certain frequency and strength. To pick up evidence of outside light rays we needed only a way to convert light rays into electrical current of the previously determined specification. This, we believed, could be done using cadmium-sulfide photocells connected to the brain through a simple vibrator power supply.

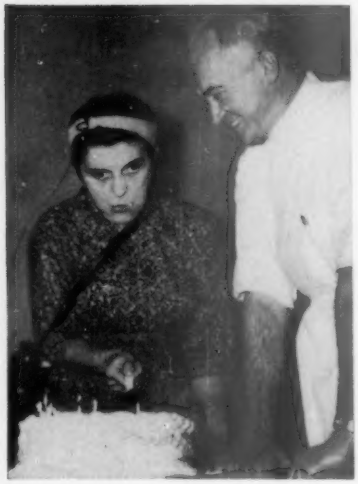
The answer to the first question would have to await the results of our first operation, which we scheduled for Oct. 29, 1957.

Time to operate

The night before the operation a small patch of hair was removed from the back of the patient's head and the skin was prepared with antiseptics. In the operating room the following morning, Novocaine was injected into the skin of the area, but otherwise no anesthetic was used. A sleeping patient could not tell us anything.

Four tiny holes were drilled through

Testing to determine optimum current — 620 μa was the result.



Betty, holding the photocell, locates the candles on her birthday cake. Dr. Button is at the right.

the back of the skull and four needles, each four inches long, were inserted through the holes directly into the substance of the brain. (This area of the brain does not have nerves of sensation, hence the patient experienced no pain.) Four stainless steel insulated wires, each 6 inches long and .003 inch in diameter, were inserted through the needles. To insure contact with the sight cells 1 millimeter of insulation had been scraped from the tip of each wire. The needles were then carefully withdrawn, leaving the wires approximately 2 inches deep within the brain and held fast by tissue elasticity.

The first crucial moment had arrived. Would we get flashes of light, or would our courageous patient remain locked in her closet of darkness?

We signaled, and a nurse quietly trundled a surgical tray up to the patient lying on the operating table. On the tray were the two small, makeshift supply units we had fabricated only the day before out of second-hand parts at a nearby electronics store. Total cost, including a brace of cadmium-sulfide photocells attached to one unit—$9.45. The vibrator's simple circuit, with the photocells connected, is shown in the diagram.

Here, perhaps, an explanation is needed. This was medical history in the making. We were about to embark upon a sea that had been charted by miracle-workers but never by scientists. We were about to attempt to demonstrate somethinng that most of our colleagues had, by scientific logic, "proved" impossible. Yet we were using makeshift, home-made, second-hand equipment of so primitive a nature that grade-school students would have laughed at it. Why?

There were two good reasons. First, we couldn't be sure what precise current specifications would be required, hence we didn't have any way of knowing what type equipment (in simple, available form) would best serve our purpose. So we chose the most elementary—a primitive vibrator supply, which we hoped would put out a square wave of the proper strength and frequency.

There was another good reason. We lacked funds. Nobody had come along to underwrite our tests. We *had* to do things the cheapest way. Perhaps this sounds "undignified" for research scientists. Nonetheless, it is true.

The patient was lying quietly, expectantly, face down on a special headrest. The four tiny wires dangled from the back of her skull, their free ends barely discernible in the reflected glare of the operating-room light.

One of the vibrator supply units was plugged into an outlet. Its two alligator clips were clamped onto the free ends of two of the wires.

"Betty," I said, "tell us if you see anything."

A hush fell over the operating room. Nurses, doctors, attendants—all paused like statues. The current was applied.

"I see a flash! I see more! I'm seeing flashes of light!"

A silent cheer seemed to emanate from the white-garbed figures encircling the patient.

"It's . . . it's gone! The flashes are gone!" There was a throb of disappointment in Betty's throat.

My colleague and I looked at each other, smiling beneath our surgical masks.

"That's as it should be, Betty," I said, trying to suppress some of the jubilance I felt. "We've turned off the current. Now—watch again."

Another pause. Then . . . "There it is! There they are! The flashes again!"

Again and again we manipulated our single little dial. Again and again our patient's responses indicated without question that she perceived flashes of light.

It was time now to forget the drama of the experience, at least for the moment, and record our findings. After multiple trials we determined that the current giving our patient the keenest flashes of light measured 25 volts and 620 μa at 75 pulses per second. The dc impedance between electrodes measured 40,000 ohms.

Surely this was far in excess of any voltages encountered in the physiological process of vision as provided by nature! To be sure it was, but nature does not have to contend with such hindrances as electrode resistance, which in our opinion was principally responsible for our relatively high voltage. Normally, vision is produced when light falls on the retinal cells in the back of the eyeball. These light rays first initiate a chemical response, which is instantly converted into an electrical current of almost infinitesimal proportions and then transmitted to the very center we had tapped—the visual cortex in the back of the brain. But what nature does, and what man must do to duplicate her wonderful processes, are sometimes vastly divergent.

Did the patient feel any discomfort during the electrical trials? Beyond a certain voltage point she became aware of sensations of mild electric current in her head, which she described as a sort of vibration. But when the current was kept at the previously determined optimum level, 620 μa, she felt no discomfort.

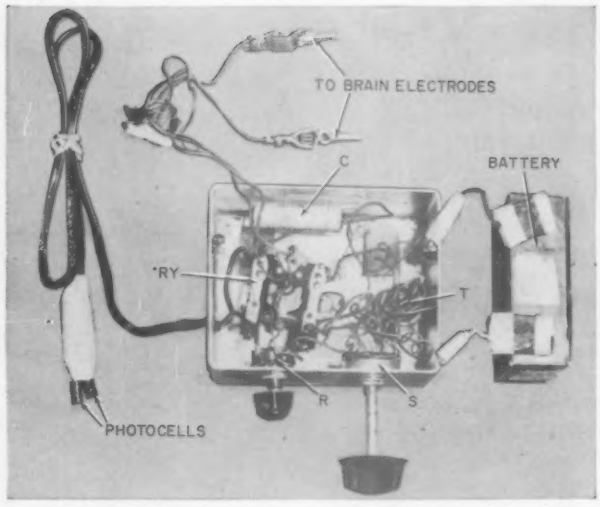
Phase two

Now, we were ready for the second phase of our experiment. We had produced the flashes of light, proving, among other things, that after 18 years of total blindness, our patient's brain cells, for reasons we have yet to determine, had *not* followed nature's usual rule and dried up.

But the flashes of light, dramatic as they were to one accustomed to total, permanent darkness, actually were of no practical value. We still had to prove that outside sources of light could be picked up and fed to our patient's brain.

I breathed a prayer and picked up a double cadmium-sulfide photocell which we had previously attached in series with one vibrator supply. Theoretically, when the dial was set to approximate the current specifications we

With vibrator hooked up, patient can detect light.



The vibrator and photocells are shown in the photo at right.

had already determined, the patient should receive light impressions if she pointed the cell at a light.

"Betty, hold this little gadget. It's like a tiny flashlight. Tell us if you see anything."

The massive operating-room lights were turned off, and a gooseneck lamp containing a 40-watt bulb was brought up to the patient. Its switch was noiseless—Betty couldn't fool us or herself.

"There! There's a light! It's not a flash. It stays on!"

Betty's hand, holding the photoelectric cells, had been guided to within a few inches of a burning 40-watt bulb.

"Now it's off. I don't see anything."

My colleague silently gave the well-known Churchillian victory sign. The light, sure enough, was off.

"Now, Betty, tell us when it comes on again. Tell us whether it's weak or strong."

There was a pause. Then . . . "There it is! But it's faint. Very faint."

I was, in fact, holding the light several feet from the photoelectric cells. Gradually I brought it closer.

"Now it's getting stronger! Now it's much stronger! Oh . . . it's dazzling!"

The final test, in the operating room that day, provided what was almost a foregone conclusion. Betty would have to find the light unaided.

She was placed in a sitting position, given the photoelectric cell and told to probe for the light.

"There it is! It's there on my right . . . over there. Right there!" she finished with an emphatic shake of the photocell as she pointed it squarely at the lamp.

"Now it's on my left. Now it's there . . . right straight ahead!"

The drama was not yet over. Betty was given a day of rest, after which the apparatus was suspended in a shoulder-bag, still attached, of course, to the tiny wires protruding from the bandage in the back of her head. She was on her own! Her task now was to walk through an obstacle course consisting of lamps strategically placed about a large room. Betty was also to find the windows by perceiving daylight.

It is almost an anticlimax to report that Betty succeeded magnificently in accomplishing these objectives. Her final triumph came, perhaps, when she perceived the candlelight on her birthday cake and accurately blew the candles out.

Plans for the future

But we realized that our experiment, though representing a milestone in medical history, was only a primitive beginning. To be sure, the initial experiment has been improved upon. Recently, new and smaller wires have been implanted in Betty's brain. By attaching two square-wave generators simultaneously to two pairs of wires, Betty could perceive, through two sets of photocells, varying patterns of light. These patterns were altered in ways that we have yet to explain when the square waves were rapidly changed to sine waves and back again. Such patterns constitute a step toward perception of images and shapes, which we believe we shall eventually obtain as we refine our surgical techniques, improve our electronic scanners and, above all, learn a great deal more about the physiology of vision.

In the immediate future, for instance, we plan to insert not two wires, not four, but several hundred. Their size will be almost microscopic, hence there will be no irritation of the brain. Furthermore no wound will remain, as we shall bury the wires permanently, allow the skull and skin to heal, and transmit the required current by induction through a solenoid hidden in the shafts of eye glasses. We are now designing various miniaturized devices to pick up visual currents, ranging from tiny photosensitive image screens to modified sonar units. The visual impressions obtained by the blind, in the not too distant future, will in our opinion approximate true vision—all through an apparatus as simple and inconspicuous as a hearing aid.

There are those who say our project cannot be successfully completed. Unfortunately, many with sight have no vision. But many with vision have no sight, and it is from these—from among the brave Bettys who will continue to volunteer for our experiments—that our faith, our hope and *their* help will spring. END

Transistor Destructors

When working with transistors, I have experienced a number of near-crises because of blunders. Here are a baker's dozen of the most common troublemakers, which I call "transistor destructors":

1. **Vtvm**—improperly grounded or switched to ohmmeter position.
2. **Ohmmeter**—set for lower ranges where current is too high.
3. **Transistor checker**—improperly set up to provide too much current or voltage, or wrong parameters.
4. **Wrong polarity**—of one or more leads.
5. **Leads**—that are easily moved into shorting position on a breadboard.
6. **Alligator clips**—that short or pop off, leaving high voltages between transistor elements.
7. **Oscillator**—with too much feedback, causing junction punch-through.
8. **Soldering iron**—with too much wattage, too close to transistor.
9. **Failure to check voltage**—before plugging transistor into socket.
10. **Bias bleeder**—that heats up and burns into a short or open.
11. **Heat sink**—not large enough or not fastened firmly to transistor.
12. **Overdriving**—when using signal generator.
13. **Reading this**—while your transistor gets hot and your emitter current avalanches.—*E. G. Homer*

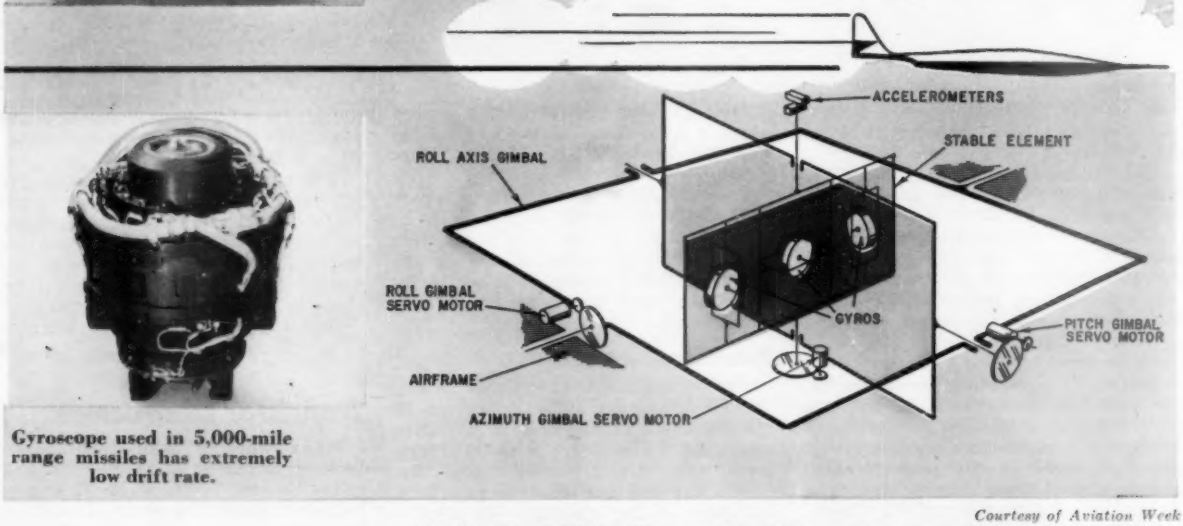
Electronic computers, gyroscopes and accelerometers, when properly combined, form a sensitive guidance system that leads a guided vehicle to any spot on earth

Inertial Guidance Directs Planes and Missiles...

By PHILIP JULIAN

Accelerometer used in 5,000-mile range ballistic missiles.

Gyroscope used in 5,000-mile range missiles has extremely low drift rate.



Courtesy of Aviation Week

Fig. 2—The stable platform consists of two or three gyroscopes, plus two or three accelerometers mounted in a gimbal arrangement which allows gyros to keep the accelerometers fixed in space, no matter how the vehicle moves.

A NEW technique called "inertial guidance" enables man to match the ability of birds to navigate unerringly over distances of thousands of miles without using radio or radar. Furthermore, the inertial-guidance system can operate in weather so bad that the birds are grounded.

Inertial guidance will direct our new intercontinental ballistic missiles (ICBM's) to targets 5,000 miles away and will also direct our newest bombers, the supersonic B-58 and hypersonic B-70, to their targets. It recently was used to guide the submarine Nautilus on its polar mission.

An inertial-guidance system is completely self-contained in the missile or airplane. It does not require ground-based radio or radar stations for assistance, nor does it radiate any electromagnetic energy itself. Inertial systems do, however, make extensive use of electronics.

There are a variety of possible inertial system configurations, depending upon the intended mission. However, all operate on the same basic principle—measuring accelerations of the missile or airplane throughout the guided portion of its flight. From these measured accelerations an airborne computer system can calculate how far the vehicle has traveled and in what direction.

The only data the inertial system computer needs is the position of the target relative to the takeoff point. The computer then continuously calculates the vehicle's position, compares it with the desired course-to-target, and generates signals which automatically steer the vehicle onto the correct course.

Because inertial systems are completely self-contained, do not themselves radiate any electromagnetic energy and do not need ground-based radio–radar stations, they offer several important military advantages:

Jam-proofness: There is no known way to jam or confuse an inertial system. By contrast, guidance systems which use radio or radar can be jammed or disrupted by enemy electronic countermeasures equipment.

Security: Unlike radio–radar guidance whose electromagnetic radiation tips off enemy that the vehicle is coming, making it possible to launch intercepting aircraft or missiles, inertial guidance gives no advance warning to the enemy.

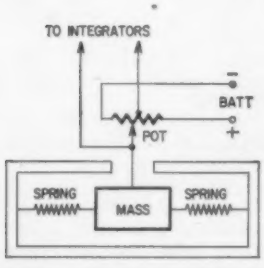


Fig. 1—Cutaway view of a simple accelerometer. Any acceleration of the vehicle in which the device is mounted causes the mass to be displaced from the center, producing a signal which is proportional to the acceleration.

Mobility: Since inertially guided missiles require no large ground-based guidance system installations, they can be launched from hidden sites or quickly moved to other locations.

Certain limitations or disadvantages are, however, inherent in inertial systems. For example, an inertial system is extremely costly because of the extreme precision required to fabricate its components. Also, errors build up with time, so accuracy is reduced on long missions. However, there are ingenious ways for getting around this problem.

How does it work?

To understand how an inertial system operates, we must first examine the basic fundamentals. These are quite simple. If you were told that an automobile had started from rest and was accelerating uniformly at the rate of 10 feet per second every second, you could calculate its distance at any given instant. The formula is:

$$\text{Distance} = \tfrac{1}{2}\ at^2$$

where a is acceleration and t is time.

For example, after 1 second the car will have covered a total distance of 5 feet ($\frac{1}{2} \times 10 \times 1$). At end of 2 seconds the auto will have moved a total of 20 feet, and after 3 seconds a total of 45 feet.

If the car were equipped with a device which could measure and indicate the acceleration, and if we had a stop watch, scratch pad and pencil, we could always calculate how far we had traveled.

Naturally, in a car equipped with an odometer–speedometer, there is no point in going to such trouble to determine how far we have traveled. But in an airplane or missile there is no such easy way of measuring distance covered and hence we turn to inertial guidance. An inertial system continuously runs through the mathematical calculation of the $D = \frac{1}{2}\ at^2$ equation.

Measuring acceleration

To perform this computation, the inertial system must continuously measure vehicle acceleration relative to the earth. To do this, the system employs devices known as "accelerometers." One of them is installed in the aircraft or missile to measure accelerations along its fore–aft axis. Another is installed so as to measure accelerations at right angles to the fore–aft axis—corresponding to a line drawn through the vehicle's wings (or where its wings would be if it had them). In certain applications, primarily ballistic missiles, a third accelerometer is installed to sense accelerations at right angles to the other two, essentially up–down accelerations relative to the earth.

In principle, these accelerometers are very simple devices, but in practice they become very complex to achieve the extremely high sensitivity and accuracy required. The simplest type of accelerometer consists of a weight (mass) which is suspended in an enclosure by two springs (see Fig. 1).

The stable platform on the right is undergoing a final series of tests to check its accuracy.

Inertial guidance gyros, accelerometers and other critical components are assembled, inspected and tested in air-conditioned dust-free rooms to prevent contamination and resultant inaccuracies.

When the accelerometer is at rest (zero acceleration), the mass is centered relative to its enclosure by the supporting springs. If the enclosure is suddenly moved along its sensitive axis (line running through springs and weight), the weight will try to "sit tight," until it is forced to come along with the enclosure by the forces exerted by the springs. This follows Newton's laws of motion which say that a body at rest tends to remain at rest unless acted upon by outside forces.

The amount that the weight is displaced from its center (zero-acceleration) position inside its enclosure is in direct proportion to the magnitude of the acceleration applied to the enclosure. If a small electrical pickoff (potentiometer, synchro, etc.) is added to measure displacement of the weight from its center position, the signal generated by the pickoff will be proportional to acceleration, and the complete device will function as an accelerometer.

Because the accuracy of the inertial guidance system can be no better than the accuracy of its accelerometers, more elaborate and more complex accelerometers than the one described must be used. The problem is made more difficult because of the wide range of accelerations the device must measure—from perhaps 100 G (100 times the acceleration of gravity) to a few thousandths or millionths of a G.

Some inertial systems employ what are called "integrating accelerometers," which sense acceleration and simultaneously perform the operation of "integration" so that their output signal is directly proportional to the vehicle's velocity or distance traveled. The integrating accelerometer is more complex than the elementary accelerometer, but simplifies the calculations which must be performed by the system's computer.

In one respect, Nature appears to have conspired to make inertial guidance systems impractical. This problem arises because the accelerometer which reacts to the vehicle accelerations it seeks to measure also responds to the force of gravity which it should ignore.

Thus an accelerometer intended to measure horizontal accelerations along the fore–aft axis of an airplane or missile would correctly sense no acceleration when the vehicle is at rest, so long as the accelerometer is truly horizontal. But if the vehicle and accelerometer were slightly off level, the accelerometer weight would be deflected from center by gravity, and the inertial guidance system would "think" the vehicle had taken off when in fact it was still at rest.

If this were the extent of the problem, it could be easily solved by leveling up the accelerometers before turning on the inertial system prior to takeoff. But even if this were done, the missile or airplane obviously is not going to maintain a perfectly level attitude once it has been launched.

The basic problem, then, is how to keep the accelerometers in position throughout the mission to prevent them from sensing gravity and confusing it with accelerations due to actual vehicle motion.

For a solution, inertial system designers turn to the gyroscope, a device that tries to hold its angular position always fixed in space. The simple spinning top, or the toy gyro which children find so amusing, demonstrates this principle.

The stable platform

A basic gyro consists of a small flywheel spun at extremely high speeds, usually by an electric motor. The shaft about which the flywheel rotates is called the "spin axis," and it is this which the gyro seeks to hold fixed in space.

If the gyro's spin axis is supported in a suitable frame, called a "gimbal," and this frame is in turn supported inside a larger gimbal, so that the outer frame can be rotated freely about the inner spin-axis gimbal, we have a simple gyro. In practice, many gyros have still a third gimbal which supports the other two.

When the gyro's flywheel has been brought up to speed, the outer gimbal(s) can be rotated or moved to any position without disturbing the position of the spin axis—just as if it were locked onto a distant star.

If such a gyro is installed in an airplane or missile, with its supporting gimbal(s) attached to the vehicle's structure, the gyro will try to keep its spin axis fixed in space regardless of changes in vehicle attitude during the flight.

If the spin axis is aligned with the true vertical before takeoff, the gyro will seek to hold this same position throughout the mission. And if the accelerometers are, in effect, mounted on the gyro spin axis (at right angles to it), they will remain horizontal throughout the flight and cannot sense the unwanted gravity acceleration.

If another gyro is installed so that its spin axis is horizontal, instead of vertical, and aligned with true north, this gyro will try to keep itself aligned with north during the flight. This provides a heading reference by which the inertial system can resolve vehicle movement into distance traveled in north–south and east–west directions.

Inertial systems usually employ two or three gyros, depending upon the type of gyro used. There are certain advantages and disadvantages to each type of configuration.

The combination of gyros, accelerometers, their supporting gimbals and related mechanisms is called a "gyro-stabilized platform," or sometimes "stabilized platform," for short (see Fig. 2).

Gyro drift

If gyros kept their spin axes fixed in space indefinitely, the problem of designing an inertial system would be easy, but once again Nature conspires to make the problem difficult. In practice, a shift in the position of the spinning gyro flywheel on its shaft of a few millionths of an inch can make the gyro wander ("drift") from its original position. A speck of dirt or a metal chip too small to be seen by the human eye, except through a microscope, in one of the gyro gimbal bearings can also introduce serious errors in gyro performance.

Any such drift in the position of the gyro spin axis tilts the accelerometers off horizontal, causing them to sense gravity acceleration, or shifts the heading reference, making the system think the vehicle is moving in a different direction than it actually is.

At the end of World War II, the gyros used in aircraft flight instruments (to indicate airplane attitude and heading) had drift rates of about 15° per hour. If inertial systems used such gyros, guidance accuracy would be completely unacceptable.

Today, industry builds gyros which have drift rates of only .01° per hour. Such a gyro has less drift after 2 months of operation than the post-war flight gyros experienced in a single hour. Gyros with still lower drift rates are under development.

To build such extremely accurate gyros, manufacturers must assemble them in ultra-clean air-conditioned rooms where the air is continuously filtered to keep out microscopic-size particles of dust. Employees must wear lint-free nylon hats and coveralls, and coats and tools are cleaned at least once a day. No one can enter without passing through airlocks equipped with high-power blowers which dust him off thoroughly.

Individual parts that go into the gyro are inspected under microscopes for possible burrs which might work loose and find their way into bearings. Deburring is done under a microscope, using precision dental tools.

The thinking heart

The heart of any inertial system is the computer which integrates acceleration signals to determine distance traveled, resolves this into distance covered in north–south and east–west directions, then compares this with the path the vehicle must fly to hit its target, and finally it calculates what signals must be sent to vehicle's controls to maneuver it onto the desired course.

These computations must be performed from takeoff throughout the guided portion of the mission. For a ballistic missile, where guidance lasts only several minutes (from there on the missile behaves like an unguided projectile), the computer must work at lightning speed and with extreme accuracy. Unless errors in missile path are quickly corrected, the missile may go out of control or miss the intended target by a wide margin.

Most of the new inertial systems

under development use tiny digital computers. These are first cousins to the familiar giant computing brains, but have been so miniaturized that they occupy no more than a couple of cubic feet in volume. Some of the newer airborne digital computers for inertial system use occupy less than 1 cubic foot.

To reduce computer size, designers have gone to all-transistor models. One such computer, being developed for intercontinental ballistic missiles, uses approximately 1,200 transistors and 10,000 diodes. Choice of targets is made by plugging appropriate subassemblies into the computer.

Schuler-tuned systems

Although industry's designers have made remarkable progress in the past 10 years in improving the performance of gyros and accelerometers, an extremely stiff price must be paid in terms of manufacturing and inspection cost to hold down errors in inertial systems intended for use on long missions.

For example, an inertial navigation-bombing system for use in a 1,000-mph bomber, like the B-58, must maintain good accuracy for 5 hours to reach a target 5,000 miles away. This is more than 60 times the period that an inertial system must provide guidance for an ICBM. This means that gyro drift errors accumulate for 60 times as long and hence can be something like 60 times greater.

Fortunately, Nature lends a helping hand here in the form of a principle first suggested in 1923 by Dr. Maxmillian Schuler, a German professor of applied mechanics. Applying this principle of the "84-minute pendulum," to provide what often is called a "Schuler-tuned" inertial system, greatly reduces error buildup on long missions by effectively washing out gyro drift and some, but not all, of the accumulated errors approximately every 84 minutes.

Hybrid systems

Even with Schuler tuning, it is not easy to get the high-precision accuracies required for long military missions. Another approach which eases the accuracies required of gyros and accelerometers is to combine the inertial system with some other navigation technique to form a hybrid system.

One such hybrid system uses a small airborne Doppler radar which measures the vehicle's ground speed accurately. The Doppler radar is used to correct for errors in acceleration measurement while the vehicle is over friendly territory where its electromagnetic radiation does not give it away. Once the vehicle approaches enemy territory, Doppler radar can be turned off and the system operated as a pure inertial system.

Another possible hybrid system configuration combines inertial and celestial navigation techniques. Electro-optical devices are available which automatically track a star, determining its azimuth (direction) and elevation position. Two such devices, together with a vertical reference such as a stabilized platform provides, furnish enough information for a computer to calculate the vehicle's position.

Such periodic star fixes can be used to correct any accumulation of errors in the inertial system when suitable stars are available for sighting. When clouds prevent obtaining a star sight, the system reverts to its pure inertial mode of operation.

Size, weight and cost

Size, weight and cost of an inertial guidance system depend upon its intended use, including such factors as mission duration and required accuracy. Although exact figures are not available because of military security considerations, an inertial guidance system for ballistic missiles is believed to weigh between 400 and 500 pounds, including the computer. A single system probably costs in the neighborhood of $250,000.

With developments now under way, weight of such an inertial system ought to come down to perhaps 200 pounds and its price down to perhaps $150,000. For short-range uses, such as in helicopters for navigation where mission times are measured in minutes and extreme accuracy is not required, it is possible to build an inertial guidance system today which weighs less than 100 pounds.

Despite its weight and price, which are high compared to other navigation guidance techniques, the many attractive military advantages of inertial guidance suggest it will find increasing use in new military missiles and aircraft. END

COVER FEATURE

TV DESIGN FOR '59

TV repairs should present less of a problem to the technician this year . . . a survey of the new sets shows that manufacturers have tilted at least one ear in his direction

By WAYNE LEMONS

IN the story of design for '59, it can hardly be disputed that one of the most unusual and extraordinary is that of the Philco Predicta line which includes the slide-out "easy-service" chassis and its separately and remotely mounted picture tubes (to be discussed in detail later). Although most other companies have not made as extensive changes in either cabinet design or circuitry, there are some very interesting and welcome trends.

Easier to fix

Ease of servicing seems to be the rallying cry with all manufacturers, and some tremendous steps have been taken in this direction. Especially is this true of portables, which in the past, for the most part, have been the nemesis of all TV technicians (so much so that one shop owner advertised for a "sawed-off" midget jeweler expressly to work on the early monstrosities).

This year, in almost all portables, the picture tube is removed from the front. Many are one-piece units so that the entire chassis and picture tube may be slipped out of the cabinet for service. Hotpoint and G-E still have a cabinet-mounted tube, but they have lengthened yoke and high-voltage leads so the set may be operated on with the chassis removed from the cabinet.

Philco's portable is the shortest of the lot and uses the SF tube, discussed later. It has a "wraparound" chassis that may be removed from the cabinet with comparative ease. However, it will be almost impossible to replace component parts, except tubes, without removing the picture tube as the wraparound chassis is not just an advertising tag. It literally wraps around the picture tube in a semicircle and hugs it tightly.

Things to look for

Power transformers are coming back this year, partly, we imagine, due to the inherent mistrust of the service technician of the "transformerless" power supplies which have come to be associated with series heaters. We note that where the "transformerless" circuit is still in use—and it is still the favorite circuit for portables — the smaller and more efficient silicon rectifier is fast replacing the selenium type. Hotpoint and G-E are using germanium rectifiers. Germanium gives slightly more output than selenium types but because it requires cooling fins, its size approximates the selenium unit. Silicon rectifiers, though, may be tucked away almost anywhere, taking up little more room than a 3AG fuse.

Crystal-diode horizontal phase detectors are still in vogue this year and Admiral, for one, has the detector unit mounted on top of the chassis in a three-prong socket, making replacement easy. Most of these are selenium types but germanium is also used. Germanium types seem to be less affected by heat and many technicians use them as replacements for selenium units. RCA still uses the time-honored Synchroguide.

This year, an interesting and timely trend is the inclusion of better audio systems in many sets. Tone controls—often dual types—placed on the front panel, denote the manufacturers' awareness of the public's interest in better sound. Output transformers in many Admiral models, for instance, are rated at 10 watts, in contrast with the 5-watt units previously used. Speakers plug in on Admiral's new models, making them easier to service. Some manufacturers, such as Philco, have models with as many at five speakers and advertise "wraparound sound" with coded cabling to prevent improper phasing. Electrostatic speakers are also used in some models.

Service technicians will find the one-piece chassis, such as used by Admiral and others, much easier to service. Admiral's chassis, like many others, is horizontal. Printed circuitry is used in if, video, audio and sync stages.

Admiral's picture tube is mounted to the front bezel, but the bezel is bolted to the chassis and the entire unit slips out the front much as Motorola has done previously, although unlike Motorola, there are no screws in the front bezel. Five screws in the bottom are all that must be removed to pull the chassis for service, after the back cover is removed. Picture-tube replacement in the Admiral is done by removing nine screws holding the chassis and tuner to the front bezel and lifting the chassis and tuner off, leaving the picture tube attached to the front-panel bezel by a single bolt clamp. Guides for the picture tube insure accurate centering of the replacement.

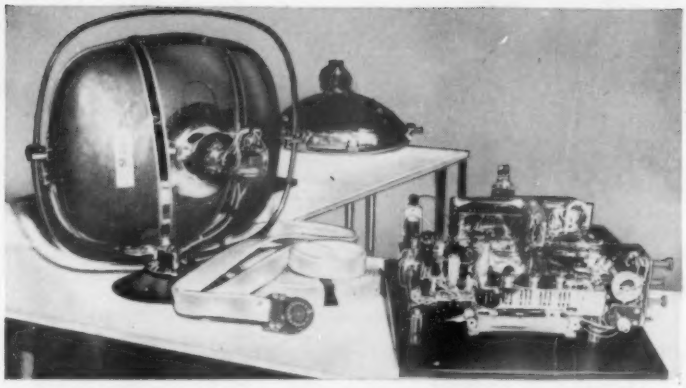
Admiral claims their new chassis runs 18° cooler than previous models. A corrugated cover on the power transformer and holes drilled around the sockets of high-heat tubes aid in this respect. Numerous other holes in the chassis allow for more liberal passage of air.

Speaking of cooling, Zenith again is using a finned power transformer. The size of the transformer proper is no larger than those in many pre-war radio receivers but the large fins make the transformer's overall size comparable to other power transformers in TV receivers. This method of cooling saves more material and wire, no doubt making a substantial saving to the manufacturer. Fins obviously keep the transformer cool by exposing more heat-conducting material to the surrounding air.

Push-pull on–off switches are seen on many '59 models. Switches of this type allow the set to be turned on and off without disturbing the volume setting. Philco models have the on–off switch on the channel selector. When the channel selector knob is pushed, the knob pops up, turning the set on and exposing the channel numbers. Channel-indicator lights of various sorts are being used extensively.

Picture tubes and printed circuits

Many manufacturers are using 110° picture tubes but, surprisingly, several manufacturers including DuMont, Zenith and others, are using short-neck



The Philco Predicta Tandem uses a long cable and a multiple-contact connector to join its remote picture tube to the main receiver chassis, which is on a slide-out shelf.

Transistor-powered Wireless Wizard for color TV provides remote adjustment of color receiver controls.

90° tubes. The SF (special form) tube used by Philco is a 110° tube but its neck length is about 2 inches shorter than the conventional 110° tube's. A flat cathode instead of the conventional round one is used in Philco's SF tube. (The EIA type number—just released —is 21EAP4.) Admiral claims to have circuitry that eliminates arcing in the 110° tube, a rather prevalent fault of early productions.

N-type fuses (the ones with ears) are used on most chassis this year. This fuse prevents installing an oversize (or undersize) fuse but does increase the number of exact replacement fuses that the shop owner must stock.

Printed circuitry, widely used by Philco, RCA and others, is not found in either the Du Mont or Zenith chassis. Printed circuitry created many disturbing service problems especially at the outset and is seldom trusted by technicians yet, although there have been improvements.

Printed circuitry has other disadvantages to the service technician: in addition to its inherent delicacy, it requires shielding. This shielding is not usually installed with the technician in mind, and because many circuits do not operate properly without it, the technician has to replace the shield before he can determine if the repair has been successful. This feature alone can make technicians irritable with their wives and families.

High-voltage and tuners

Most companies have upped the "horsepower" for '59. High-voltage supplies are being advertised at 18 and 20 kv. Higher voltage makes for more brightness and better picture focus by preventing blooming of the spot on highlights, but by the same token a higher anode voltage requires more deflection power. Because of this, we find horizontal amplifier tubes of the higher plate dissipation variety, such as the 6CD6 and 6DQ6, being used in these higher-voltage chassis.

Tuners are still mainly cascode in the more expensive chassis but *tetrode* tuners, especially in portables, are appearing in increasing numbers. RCA, Philco, Hotpoint and G-E have tetrode tuners in several models. The tetrode eliminates one grid, so noise is reduced, while the high gain of the pentode is maintained. As noise, theoretically at least, is proportional to the number of grids in a tube, the tetrode is a new approach to the design of a low-noise front end. The tube used is a 2CY5 or its 6-volt equivalent, the 6CY5. Most Magnavox, Sparton and Coronado chassis use the neutralized triode 2BN4, 6BN4 "fireball" tuner made by Standard Coil.

Remote control

Remote controls are available from most manufacturers this year. The Zenith Space Command and a similar unit called Son-R used with Admirals work without circuitry in the control unit and no connecting wires. A microphone picks up 40-kc signals emitted by tuned rods that are struck with a hammer when a button is pushed. This year there are step volume positions on both the Space Command and Son-R. RCA has announced, although they evidently do not expect to market for some time, a remote control for color. Admiral's Son-R remote unit is held to the cabinet by a magnet when not in use.

Color TV

RCA is still the only manufacturer pushing color and the RCA color set is similar in many respects to last year's model but with some very definite and worth-while improvements. The convergence controls are mounted on a panel board (with the exception of the dc center-convergence magnets on the picture-tube neck) that hangs from the top, inside the cabinet. When making convergence adjustments, the panel board with the controls is removed and placed on two screws which hold it upright at the back and above the cabinet.

The picture tube of the RCA color set is all glass as was the '58 model. To increase the apparent brightness of the tube, the shadow-mask holes have been enlarged around the center of the tube face. These larger holes allow more light to strike the face plate near the center of the tube where most of the action takes place.

Although at first thought this might appear to complicate convergence due to impurity, this is not the case. Center convergence and purity have always been fairly simple to come by. Actually, overall convergence of the new RCA is much easier, due largely to improved circuitry and the go–no-go action of the dynamic convergence controls. The result of turning a control is a definite change, permitting you to see what is happening, quickly and unquestionably. Action of these controls is as definite as height or linearity adjustments of black and white. Potentiometers are used for most settings; the three coil-type adjustments have fast threads and may be quickly set with the conventional hexagon tool.

New tubes

In general, service technicians and especially shop owners are somewhat fed up with a new crop of tubes each year, because it increases shop inventories and also increases the number of tubes that must be carried on each call. In fact, it has been rumored that one manufacturer of golf buggies is considering building a motorized tube caddy. Be that as it may, we find these new tubes and there are no doubt others. The 1K3 and 1G3 are high-voltage rectifiers, similar to the 1B3. The 6EA8 is similar to the 6U8. 'CY7 and 'DR7 series are twin triodes used as vertical oscillator and amplifier. The

(*Continued on page* 78)

"HEATHKITS®

gave me my start and I'm still sold!"

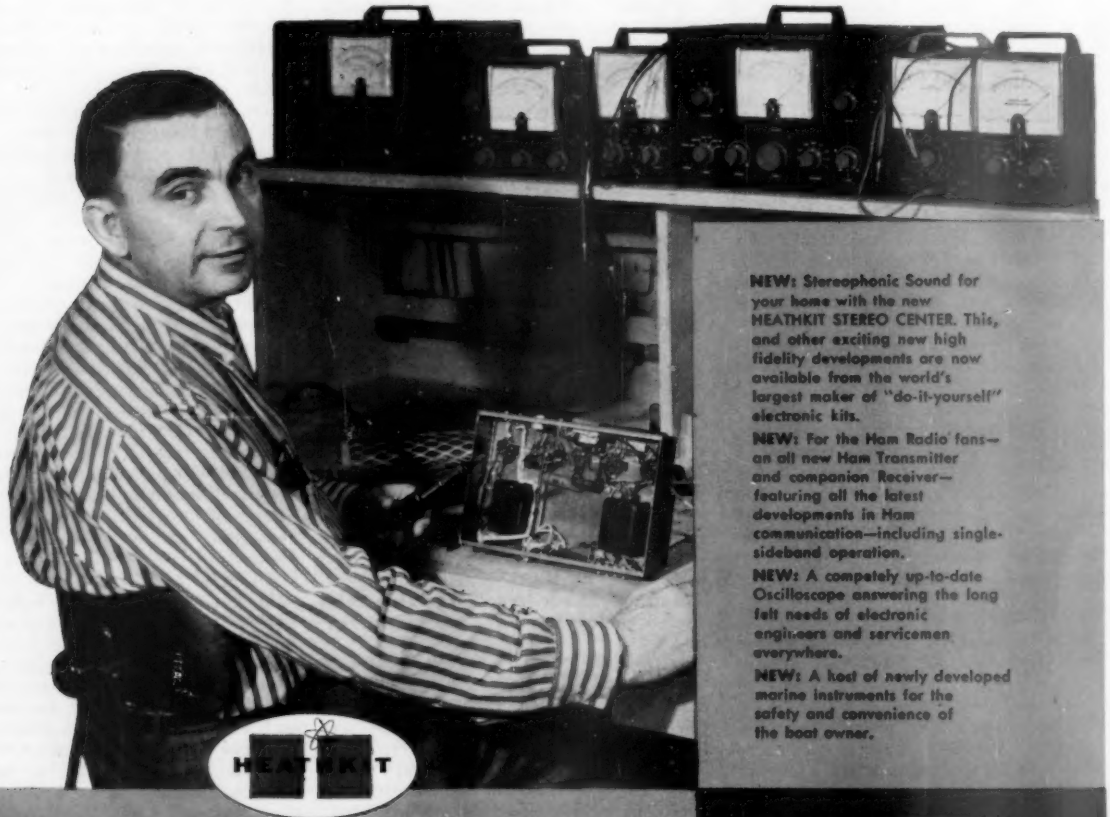
"... they are my lowest cost way to real quality and dependability in electronic equipment of any kind ...

... The clean, modern styling of HEATHKITS make me proud to own them. They make a handsome and useful addition to my workshop.

... Rigid quality standards of components used in HEATHKITS assure me of performance equal to or surpassing instruments costing many times more.

... after assembling a HEATHKIT myself, I know what "makes it tick"... I know that the thoughtful circuitry design and name-brand components used throughout guarantee me years of trouble-free service.

... HEATHKITS cost me half as much as ordinary equipment ... and I get so much more. In assembling my own instruments I am sure of the quality that goes into them. Plus the complete assembly and operating instructions as well as detailed schematics that are at my fingertips for future reference."



NEW: Stereophonic Sound for your home with the new HEATHKIT STEREO CENTER. This, and other exciting new high fidelity developments are now available from the world's largest maker of "do-it-yourself" electronic kits.

NEW: For the Ham Radio fans—an all new Ham Transmitter and companion Receiver—featuring all the latest developments in Ham communication—including single-sideband operation.

NEW: A completely up-to-date Oscilloscope answering the long felt needs of electronic engineers and servicemen everywhere.

NEW: A host of newly developed marine instruments for the safety and convenience of the boat owner.

HEATH COMPANY Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

The HEATH TIME PAYMENT PLAN allows you to outfit your whole workshop at one time with needed test instruments while you pay in easy monthly installments.

HEATHKIT

PROFESSIONAL OSCILLOSCOPE KIT

An exciting development in the Heathkit test instrument line is the introduction of the Heathkit model OP-1 Professional Oscilloscope. Emphasizing complete flexibility in any application, the OP-1 features DC coupled amplifiers and also DC coupled CRT tube un-blanking. The triggered sweep circuit will operate on either internal or external signals and may be either AC or DC coupled. The polarity of the triggering signal may also be selected, and any point on the wave form may be selected for the start of the sweep by using the "triggering level" control. An automatic position is also provided, in which the sweep recurs at a 50 cycle rate, but can be driven over a wide range of frequencies with no additional adjustments. The sweep frequencies are provided by switch-selected base rates of 2 and .2 milliseconds/CM, and 20, 2, and 1 microseconds/CM, in conjunction with a continuously variable 10 to 1 multiplier. Sweep frequencies are calibrated to within 10% at all control settings, and the sweep frequency may be reduced by adding capacity to the "ext. cap" binding post on the front panel. A 5ADP2 flat face CR tube is used for accurate readings on an edge lighted grid screen. A high quality conetic-fernetic CR tube shield prevents stray AC fields from distorting trace. A 12-position vertical attenuator is calibrated in volts-per-CM and the horizontal sweep is calibrated in time-per-CM. Prewired terminal boards are used for rapid, easy assembly of all critical circuits. Simply install and connect the color coded leads. Power supply is transformer operated utilizing silicon diode rectifiers and is fused for protection. Under development for over a year the OP-1 promises outstanding results in any application requiring the use of an oscilloscope.

HEATHKIT OP-1 **$179.95**

Here's the scope you've been waiting for!

Laboratory Performance At Less Than Utility Scope Price

HEATHKIT O-12 **$65.95**

A Scope You Will Be Proud To Own

HEATHKIT OM-3 **$39.95**

"EXTRA DUTY" 5" OSCILLOSCOPE KIT

Top quality features at half the cost of ordinary equipment sum up the advantages of this popular kit. Critical observations in your laboratory or shop are handled easily, with clear, sharp pattern displays in every application. Vertical frequency response extends from 3 CPS to 5 mc +1.5 db —5 db without extra switching. Response is down only 2.2 db at 3.58 mc. The Heath patented sweep circuit functions effectively from 10 CPS to better than 500 kc in five steps, giving you 5 times the usual sweep obtained in other scopes. An automatic sync circuit with self-limiting cathode follower provides excellent linearity and lock-in characteristics. Extremely short retrace time and efficient blanking action. Both vertical and horizontal output amplifiers are push-pull and the scope incorporates a 1 V peak-to-peak calibrating source, step attenuated and frequency compensated vertical input, plastic molded capacitors and top quality parts throughout. The 11-tube circuit features a 5UP1 cathode ray tube, and provision is made for Z-axis input for intensity modulation of the beam. Frequency response of the horizontal amplifier is within ±1 db from 1 CPS to 200 kc. Horizontal sensitivity is 0.3 volts RMS per inch. Construction is simplified through the use of two metal circuit boards and precut, cable wiring harness. Shpg. Wt. 22 lbs.

GENERAL PURPOSE 5" OSCILLOSCOPE KIT

For servicing and routine laboratory work this fine kit is a favorite with technicians throughout the country. It incorporates many extras not expected at this low price. Features wide vertical amplifier frequency response, extended sweep generator operation, and improved stability. Frequency response of the vertical amplifier is within ± 3 db from 4 CPS to 1.2 mc. Vertical sensitivity is .09 volts RMS per inch at 1 kc. Sweep generator functions reliably from 20 CPS to over 150 kc. A modern etched circuit board is featured for high stability and reduces assembly time considerably. Standard components are mounted on this board with each position clearly marked preventing wiring errors. Both vertical and horizontal amplifiers are push-pull types. Uses a 5BP1 CRT. Provision for external or internal sweep or sync, built in 1 V peak-to-peak reference voltage and calibrated grid screen. An adjustable "spot shape" control is provided to insure a sharp trace. Input to the vertical amplifiers is through a step attenuated, frequency compensated circuit. The OM-3 is an extremely versatile instrument and has a multitude of practical uses in electronic testing fields. Particularly useful in alignment of television receivers, for testing audio amplifiers and circuits, and checking the quality of modulated RF signals in Ham Radio transmitters. Shpg. Wt. 22 lbs.

Equip Your Service Bench...

HEATHKIT CD-1 **$59.95**

Cash In Now On Color TV

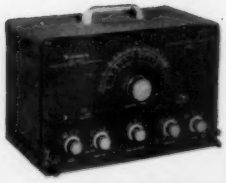
★ 10 VERTICAL COLOR BARS
★ CRYSTAL CONTROLLED ACCURACY
★ CHOICE OF 6 DIFFERENT PATTERNS

COLOR BAR AND DOT GENERATOR KIT

Colored television is now a reality and as the number of these sets increase the need for a reliable service instrument is apparent. Nothing on the market . . . in this type of generator has as many features as the CD-1 at such a tremendous price saving. This unit combines two basic color service instruments, a color bar generator, and white dot generator in one versatile portable unit which has crystal controlled accuracy and stability for steady locked-in patterns (requires no external sync leads). Color receivers converged with the CD-1 will still be converged properly on a television program from the station. The 13-tube circuit has been carefully laid out for ease of assembly and provides choice of six different patterns. Produces white-dots, cross hatch, horizontal and vertical bars, ten vertical color bars, and a new shading bar pattern for screen and background adjustments. Variable RF output on any channel from 2 to 6. Positive or negative video output, variable from 0 to 10 volts peak-to-peak. Crystal controlled sound carrier with off-on switch. Voltage regulated power supply uses long-life silicon rectifiers. Kit includes three crystals and test lead, plus an information packed instruction manual covering convergence, and screen and background adjustments of a color TV set. Compare with other generators on the market and you will see that this instrument is loaded with extras and top quality all the way through. Shpg. Wt. 13 lbs.

HEATHKIT TS-4A **$49.50**

For fast, easy alignment of TV sets



HEATHKIT AG-10 **$49.95**

Sine and square waves for countless uses

HEATHKIT MM-1 **$29.95**

High accuracy in a portable meter

HEATHKIT M-1 **$17.95**

An all-round meter of many uses

TV ALIGNMENT GENERATOR KIT

This generator has many special design features for flexible, easy operation and reliability. The all-electronic sweep circuit insures stability and covers 3.6 mc to 220 mc in four bands. Sweep deviation is controllable from 0 to 42 mc. Crystal and variable marker oscillators are built in. Crystal (included with kit) provides output at 4.5 mc and multiples thereof. Variable marker provides output from 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking and phasing control also provided. A truly outstanding number of features at a tremendous price saving. Shpg. Wt. 16 lbs.

SINE-SQUARE GENERATOR KIT

High quality sine and square waves are produced by this generator over a wide range. Frequency response is ±1.5 db from 20 CPS to 1 mc on both sine and square waves, with less than .25% sine wave distortion, 20 to 20,000 CPS. Output impedance is 600 ohms on sine wave and 50 ohms on square wave (except on 10 volt range). Square wave rise time less than .15 microseconds. Five-position bandswitch—continuously variable tuning—shielded oscillator circuit—separate step and variable output attenuators in ranges of 10, 1 and .1 volts with extra range of .01 volt on sine wave. Shpg. Wt. 12 lbs.

20,000 OHMS/VOLT VOM KIT

This meter is ideal for use in field applications where accuracy is important. Employs a 50 ua 4½" meter, and features 1% precision multiplier resistors for high accuracy. Requires no external power for operation (batteries supplied). Sensitivity is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5,000 volts AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are x 1, x 100 and x 10,000 Covers -10 db to +65 db. Batteries and test leads are also included with this kit. Shpg. Wt. 6 lbs.

HANDITESTER KIT

Small enough to carry with you wherever you go, this fine handitester is ideal for use in portable applications when making tests away from the work bench or as an "extra" meter in the service shop, when the main instruments are occupied. The combination function-range switch simplifies operation. Measures AC or DC voltage from 0-10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 and 0-300,000. Top quality precision components employed throughout. Very popular with home experimenters and electricians. Shpg. Wt. 3 lbs.

with Low-Cost Dependable Heathkits

HEATHKIT

ETCHED CIRCUIT VTVM KIT

The fact that this instrument is outselling all other VTVM's says a great deal about its accuracy, reliability, and overall quality. The precision and quality of the components used in this VTVM cannot be duplicated at this price through any other source. Its attractive appearance as well as its performance will make you proud to own it. A large 4½" panel meter is used for indication, with clear, sharp calibrations for all ranges. Front panel controls consist of a rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit. An etched circuit board is employed for most of the circuitry, cutting assembly time and eliminating the possibility of wiring errors. It also assures duplication of laboratory instrument performance. This multi-function VTVM will measure AC voltage (RMS), AC voltage (peak-to-peak), DC voltage and resistance. There are 7 AC (RMS) and DC voltage ranges of 1.5, 5, 15, 50, 150, 500 and 1500. In addition there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400 and 4,000. Seven ohmmeter ranges providing multiplying factors of x 1, x 10, x 100, x 1000, x 10 k, x 100 k and x 1 megohm. Center scale resistance readings are 10, 100, 1000, 10 k, 100 k ohms, 1 megohm and 10 megohms. A zero-center scale db range is also provided. Battery and test leads included with kit. Shpg. Wt. 7 lbs.

HEATHKIT V-7A **$25.95**

World's largest selling VTVM kit

★ LARGE EASY-TO-READ 4½" 200 UA METER
★ 1% PRECISION RESISTORS EMPLOYED FOR HIGH ACCURACY

HEATHKIT C-3 **$19.50**

Checks all types of condensers accurately

HEATHKIT T-4 **$19.95**

Locate faults quickly by tracing signals

HEATHKIT SG-8 **$19.50**

Easy-to-build—prewound and calibrated coils

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately. Capacity measurements are made in four ranges of .00001 mfd-.005 mfd; .001 mfd-.5 mfd; .1 mfd-50 mfd; 20 mfd-1,000 mfd. Checks paper, mica, ceramic, and electrolytic condensers. Leakage test provides switch selection of five polarizing voltages, 25 volts to 450 volts DC to indicate condenser operating quality under actual load conditions. Electron beam "eye" tube indicates balance and leakage. A spring return test switch automatically discharges condenser under test and eliminates shock hazard to the operator. Measures resistance from 100 ohms to 5 megohms in two ranges. Shpg. Wt. 7 lbs.

VISUAL-AURAL SIGNAL TRACER KIT

Here is a brand new signal tracer completely redesigned with compact dimensions and new circuit layout. Features built-in speaker and electron beam "eye" tube for signal indication and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. RF and audio inputs are provided in one convenient probe with switch on probe to select either input. Useful for checking microphones, phono cartridges, record changers, tuners, etc. Makes a handy substitution speaker for servicing TV sets at the shop. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 6 lbs.

RF SIGNAL GENERATOR KIT

Save valuable time in aligning RF tuned circuits of all kinds with this easy-to-use kit. Also a quick way to trace signals in faulty RF, IF and audio circuits. Designed for general service applications the SG-8 covers 160 kc to 110 mc on fundamentals in five bands, and from 110 mc to 220 mc on calibrated harmonics. The entire oscillator circuit is built on a special sub-chassis, using prewound and calibrated coils. No further calibration is required so it is ready to use as soon as construction is completed. RF output is in excess of 100,000 microvolts, controlled by both step and continuously variable controls. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

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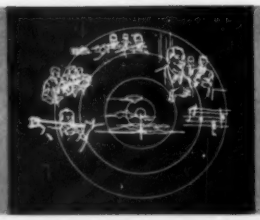


Enjoy Rich 3 Dimension Sound...

Beautifully Styled with Plenty of Room for the Most Complete Stereo System

AVAILABLE IN THE FOLLOWING MODELS:
Model SE-1B—Stereo Equipment Cabinet (birch)
Model SE-1M—Stereo Equipment Cabinet (mahogany)
$149.95 ea.

Model SC-1BR—Stereo Wing Speaker Enclosure (birch—right end)
Model SC-1BL—Stereo Wing Speaker Enclosure (birch—left end)
Model SC-1MR—Stereo Wing Speaker Enclosure (mahogany—right end)
Model SC-1ML—Stereo Wing Speaker Enclosure (mahogany—left end)
$39.95 ea.

STEREO EQUIPMENT CABINET KIT

Imagine!... Stereophonic sound in your own home. This superbly designed cabinet holds all of your hi-fi stereo equipment and lends striking elegance to your living room. The attractive gold and black panels, trim and hardware brilliantly highlight the overall effect. Rich toned grille cloth, flecked in gold and black, complement the cabinet. The unit has ample room provided for an AM-FM tuner, tape deck, stereo preamplifier, amplifiers, record changer, record storage and speakers. Beautifully grained ¾" solid core Philippine mahogany or select birch plywood is used for construction. The top features a shaped edge and sliding top panel for easy access to the stereo tape deck and stereo preamplifier. Sliding doors are employed for convenient front access to the changer and record storage compartment. All parts of the cabinet are precut and predrilled for simple assembly. The speaker wings and center cabinet may be purchased separately if desired. Note: the kit is delivered equipped with panels precut to accommodate Heathkit components and also blank panels to cut out for your own equipment. Measurements of the individual component areas follow: tape deck and preamplifier area 20¾" L. x 17¾" W. x 10" D., record changer area 21" W. x 16" D. x 9⅝" H., record storage area 22⅝" W. x 14½" H. x 12½" D., speaker wing area (inside) 14" W. x 29½" H. x 15¾" D., AM-FM Tuner area 20½" W. x 5¼" H. x 14" D., amplifier (2 areas) 15¼" W. x 10¾" H. x 13¼" D.

Model HH-1B Birch
Model HH-1M Mahogany
Now only **$299.95** each

The Same Superior Performance At a New Low Price

HEATHKIT SS-2 **$39.95**

OPTIONAL LEGS EXTRA

Economical Hi-Fi For Your Home

"LEGATO" HI-FI SPEAKER SYSTEM KIT

The increasing sales of the Legato has made more economical quantity production possible so we are passing the savings on to you by offering you this magnificent speaker system at a reduced price. Truly a "queen" among hi-fi speaker systems, the Legato was specially designed to meet and surpass the most stringent requirements of high fidelity sound reproduction. Two 15" Altec Lansing low frequency drivers cover frequencies of 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. A unique crossover network is built in making electronic crossovers unnecessary. Internal reflections are absorbed by splayed back panel and a 3" fiber glass lining. The Legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Cabinet construction is ¾" veneer surface plywood in either African mahogany or white birch and measures 41" L. x 22¼" D. x 34" H. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

True high fidelity performance at modest cost make this basic speaker system a spectacular buy for any hi-fi enthusiast. The amazing performance of this popular kit is made possible by the use of high quality speakers in an enclosure specially designed to receive them. The cabinet is a ducted port bass reflex type enclosure 11½" H. x 23" W. x 11¾" D. It features an 8" mid range woofer to cover 50 to 1600 CPS and a compression-type tweeter with flared horn covering 1600 to 12,000 CPS. Both speakers are by Jensen. The adjustable flared tweeter horn allows speaker to be used in either upright or horizontal position. The cabinet is constructed of ½" veneer surfaced plywood suitable for light or dark finish of your choice. All wood parts are precut and predrilled for easy assembly. Shpg. Wt. 25 lbs.

Attractive brass tip accessory legs convert SS-2 into attractive consolette. Legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26 $4.95

with a Heathkit Stereo System

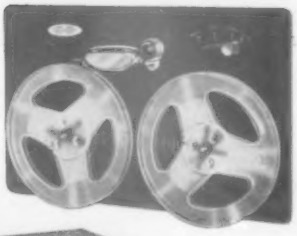
HEATHKIT

HIGH FIDELITY TAPE RECORDER KIT

Popular request for high quality, low cost tape recording and playback facilities have prompted the addition of this fine unit to our line. The TR-1A provides monaural record /playback with fast forward and rewind functions. Incorporates separate erase and combination record /playback heads. Two speeds, 7½ and 3¾ IPS, are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-65,000 CPS. The extremely simple mechanical assembly is ideally suited to kit construction. One control lever selects all functions on deck, greatly simplifying operation. Mount in vertical or horizontal position. The model TE-1 record /playback tape preamplifier, supplied with the mechanical assembly, provides NARTB playback equalization. A record interlock prevents accidental tape erasure. Recording level is indicated by a 6E5 "magic eye" tube. A two-position input selector switch provides for mike or line input. Separate record and playback gain controls. Filament balance control allows adjustment for minimum hum level. Cathode follower output from playback channel is approximately 600 ohms impedance. Two circuit boards are used for easy assembly. Templates and instructions are provided to cut out panels for mounting. Overall dimensions of tape deck and preamp are 15½" W. x 13½" H. x 8" D. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. (Tape mechanism not sold separately.) Shpg. Wt. 22 lbs.

TAPE RECORDER ELECTRONICS KIT

The model TE-1 Electronics Kit can be purchased separately to replace the electronics in your present tape recorder, or used in addition to it for stereo playback of pre-recorded tapes where a second playback channel is required. Circuit may be modified for use with different head types. Shpg. Wt. 9 lbs.

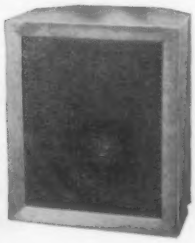


HEATHKIT TR-1A **$99.95**

(Includes tape deck, tape recorder electronics, mike and roll of tape.)

Make Your Own Home Recordings

HEATHKIT TE-1 **$39.95**



HEATHKIT SS-1B **$99.95**

Fill out the Hi-Fi Range of Your SS-2 Speaker

HEATHKIT SW-1 **$24.95**

Save Time Rewinding Tape

HEATHKIT TK-1 **$9.95**

All The Tools You Need For Building Heathkits

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

This is not a complete speaker system in itself, but is designed to extend the range of the SS-2. The SS-1B uses a 15" woofer and a small super tweeter to supply the very high and very low frequencies to fill out the response of the basic SS-2. The SS-2 and SS-1B when used together, form an integrated four speaker system. The SS-2 and SS-1B combination provide an overall response of ±5 db from 35 to 16,000 CPS. The kit includes circuit for crossover at 600, 1600 and 4,000 CPS. Impedance is 16 ohms and power rating is 35 watts. A control is also provided to limit output of super tweeter. The handsome cabinet measures 29" H. x 23" W. x 17½" D. Constructed of beautiful ¾" veneer surface plywood. Complete step-by-step instructions make this kit easy to build. No woodworking experience required. Shpg. Wt. 80 lbs.

"SPEEDWINDER" KIT

This handy device leaves your tape recorder free for operation while it rewinds tape at the rate of 1200' in 40 seconds. Prevents unnecessary wear to the tape and recorder by eliminating wear against guides and heads. It will handle up to 10½" tape reels as well as 800' reels of 8 and 16 millimeter film. A very useful aid to operators of movie projection equipment. The Heathkit Speedwinder features an automatic shutoff which prevents whipping of tape when it has rewound. A manual shutoff is also provided. An automatic braking device is built in for protection against power failure. Driven by a heavy duty four pole motor. Handsome cabinet is constructed of furniture grade plywood. Step-by-step instructions are provided to make this kit easy to assemble even by one with no experience. Shpg. Wt. 12 lbs.

COMPLETE TOOL SET

A clear illustration of just how easy Heathkit building is. The pliers, diagonal sidecutters, two screw drivers and soldering iron are all the basic tools you need for building practically any Heathkit. Pliers and sidecutters are equipped with insulated rubber handles. The American Beauty soldering iron has a replaceable tip to facilitate cleaning. All the tools are of top quality case hardened steel for rugged duty and long life. With these simple, inexpensive tools in your hand you need not be afraid to tackle the most elaborate kit. The manual included with this handy kit provides you with many useful tips on the use and care of your tools. It shows the all important step of making proper solder connections. A truly worthwhile investment for the beginner in electronic kit building. Shpg. Wt. 3 lbs.

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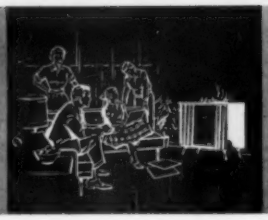


Plan Your Hi-Fi System...

HEATHKIT SP-2 **$56.95**

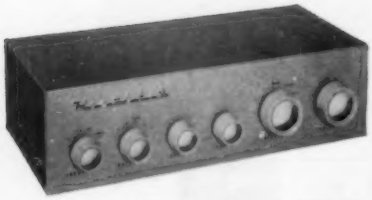
Model SP-1 (monaural) $37.95

Model C-SP-1 (converts SP-1 to SP-2) $21.95

Control both stereo channels simply and conveniently

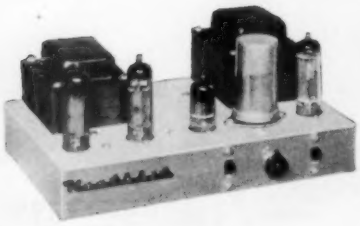
MONAURAL-STEREO PREAMPLIFIER KIT

This expertly designed preamplifier provides all the controls required for either standard monaural (single channel) or stereo (dual channel) sound reproduction. Features building block design . . . you can start with a basic preamplifier and add a second channel for stereo later on, without rewiring. Second channel plugs in for fast conversion. The complete model SP-2 (stereo) features twelve separate inputs, six on each channel with input level controls. Six dual-concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch (separate on-off switch). The function switch provides settings for stereo, two-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. Tape input has NARTB equalization and input selector provides for RIAA, LP, 78 record compensation. EF86 tubes are used in the input stages along with hum balance controls to assure low hum and noise. Two cathode follower outputs with level controls provided in addition to two separate tape outputs for stereo recording. A remote balance control with twenty feet of cable allows balancing the stereo system from listening position. Construction is greatly simplified through the use of two printed circuit boards (one in each channel) and encapsulated printed circuits. The beautiful vinyl clad steel cover has leather texture in black with inlaid gold design. Built-in power supply.



HEATHKIT WA-P2 **$19.75**

Finger-tip controls for your operating convenience



HEATHKIT UA-1 **$21.95**

A low cost versatile performer

"MASTER CONTROL" PREAMPLIFIER KIT

Designed as a control center for basic amplifiers the WA-P2 provides you with true high fidelity performance for the finest audio systems. Five switch-selected inputs accommodate a record changer, tape recorder, AM-FM tuner, TV receiver, microphone, etc., each with level control. Provision is also made for a tape recorder output. Ideal for "remote" installations, the WA-P2 features a low impedance cathode-follower output circuit allowing greater length of output lead. Full frequency response is obtained within ±1½ db from 15 to 35,000 CPS and will do full justice to the finest available program sources. Equalization is provided for records through separate turnover and rolloff switches for LP, RIAA, AES, and early 78's. A special hum balance control allows setting for minimum hum level. Power for operation is required from basic amplifier or external source. Shpg. Wt. 7 lbs.

"UNIVERSAL" 12-WATT AMPLIFIER KIT

A true high fidelity performer in every sense of the word, the UA-1 makes an ideal basic amplifier for any hi-fi system and is a perfect addition to gear your present hi-fi system for stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range (20 to 20,000 CPS) at full 12 watt output. The on-off switch is located right on the chassis and an octal socket is provided for connecting a preamplifier for remote control operation. The specially designed output transformer provides excellent stability and frequency response. Taps for 4, 8 and 16 ohm speakers, with switched damping for "unity" or "maximum" on the 16-ohm tap. An input level control is provided for use in wired music systems where a preamplifier is not required. This versatile unit is the latest addition to the fine line of Heathkit basic amplifiers. Shpg. Wt. 13 lbs.

With Flexible Heathkit Components

HEATHKIT

DELUXE AM-FM TUNER KIT

Outstanding features in both styling and circuitry are combined in this 16-tube deluxe AM-FM combination tuner to bring you the very finest in program sources, for your listening enjoyment. Features include three circuit boards for easy construction and high stability—prewired, prealigned FM front end—built-in AM rod antenna—tuning meter—AFC (automatic frequency control) with on-off switch and flywheel tuning. AM and FM circuits are separate and individually tuned making it ideal for stereo applications. Cathode follower outputs with individual controls are provided for both AM and FM. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. The unique IF limiter design automatically provides the number of limiting and IF stages required for smooth non-flutter reception. The silicon diode power supply is extremely conservatively rated and is fuse protected assuring long service life. A tuning meter shows when the station is tuned-in for clearest reception on AM or FM. Use of three circuit boards greatly simplifies construction of circuit, you do only a minimum of wiring. All IF transformers and coils are prealigned so it will be ready to operate as soon as construction is completed. Appearance of this top-quality unit is further enhanced by the vinyl-clad steel cover in black with inlaid gold design. A multiplex jack is provided for addition of converter unit to receive multiplex stereo broadcasts on FM. A top dollar value.

HEATHKIT PT-1 **$89.95**

A deluxe AM-FM tuner combination loaded with extras!

HEATHKIT BC-1A **$26.95**

Wide range broadcast reception

HEATHKIT FM-3A **$26.95**

Enjoy static-free FM entertainment

HIGH FIDELITY AM TUNER KIT

This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuit features broad bandwidth to assure low signal distortion. Audio response is ±1 db from 20 CPS to 9 kc, with 5 db of pre-emphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent and the tuner covers the entire broadcast band from 550 to 1600 kc. Quiet performance is assured by a 6 db signal-to-noise ratio at 2.5 uv. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

HIGH FIDELITY FM TUNER KIT

FM programming, your least expensive source of high fidelity will provide you with years of real enjoyment. This beautifully styled FM tuner features broad-banded circuits for full fidelity and better than 10 uv sensitivity for 20 db of quieting to pull in stations with clarity and full volume. Covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit, making special alignment equipment unnecessary. Edge-lighted glass slide rule dial for easy tuning. You need not wait to have FM in your home at this low price. Shpg. Wt. 8 lbs.

HEATH COMPANY • a subsidiary of Daystrom, Inc. • **Benton Harbor 20, Mich.**

You can be sure you're buying High Fidelity

HEATHKIT W-7M **$54.95**

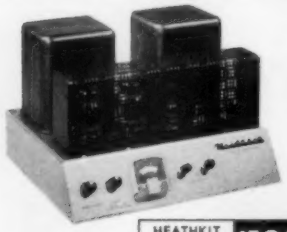
55 watts of hi-fi power at only $1 per watt

★ BEAUTIFULLY STYLED IN BLACK AND GOLD

★ UNITY OR MAXIMUM DAMPING

"EXTRA PERFORMANCE" 55 WATT HI-FI AMPLIFIER KIT

Another Heathkit first! An honestly rated high power amplifier with many top quality features at less than a dollar per watt. Full audio output is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Unique paired output connections permit instant switch selection of "unity" or "maximum" damping factors for all 4, 8 or 16 ohm speakers. Each output has an optimized current feedback circuit for unity damping so that there will be no compromise in performance when any of the impedances is used. This current feedback circuitry is entirely shorted out when not in use to obtain the highest possible damping factor. Features include level control and "on-off" switch right on the chassis plus provision for remote control from preamp, etc. Famous "bas-bal" circuit conveniently balances EL-34 output tubes. These heavy duty push-pull tubes operate into a high quality tapped-screen transformer designed especially for this unit. A 70-volt output on the transformer provides for P.A. or large music systems. The silicon diode power supply features a protection device that controls current until tubes have warmed up, greatly increasing service life of all components. The stylish black and gold case measures 6" H. x 8½" D. x 15" W. Convenient pilot light on the chassis. Thoughtful circuit layout makes this kit easy to build. Dollar for watt you can't beat this buy. Shipped express only. Shpg. Wt. 28 lbs.



HEATHKIT W-6M **$109.95**

Plenty of Reserve Power Without Distortion

"HEAVY DUTY" 70-WATT HI-FI AMPLIFIER KIT

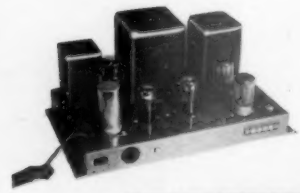
Here is an amplifier that will provide the extra "push" needed to drive any of the fine speaker systems available today, for truly fine performance at any power level. Silicon-diode rectifiers are used to assure long life and a heavy duty transformer gives you extremely good power supply regulation. Variable damping control provides optimum performance with any speaker system. Quick change plug selects 4, 8 and 16 ohms or 70 volt output and the correct feedback resistance. Frequency response at 1 watt is from 5 CPS to 80 kc with controlled HF rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 CPS and IM distortion is below 1%, 60 and 6,000 CPS. Hum and noise 88 db below full output. Metered balance circuit. Designed especially for easy assembly and years of dependable service. Shipped express only. Shpg. Wt. 52 lbs.

HEATHKIT W-5M **$59.75**

Top-Flight Performance for the Critical Listener

25-WATT HI-FI AMPLIFIER KIT

Considered top value in its power class by leading independent research organizations, the W-5M incorporates all the design features required by the super critical listener. Features include a specially designed Peerless output transformer and KT66 tubes. The circuit is rated at 25 watts and will follow instantaneous power peaks of a full orchestra up to 42 watts. A "tweeter saver" suppresses high frequency oscillation and a new type balancing circuit facilitates adjustment of the "dynamic" balance between output tubes. Frequency response is ±1 db from 5 CPS to 160,000 CPS at 1 watt and within 2 db from 20 to 20,000 CPS at full 25 watts output. Harmonic distortion is less than 1% at 25 watts and IM distortion is 1% at 20 watts (60 and 3,000 CPS, 4:1). Hum and noise are 99 db below 25 watts for truly quiet performance. Rich black and gold colored styling. Shipped express only. Shpg. Wt. 31 lbs.



HEATHKIT W4-AM **$39.75**

Faithful Sound Reproduction with Minimum Investment

20-WATT HI-FI AMPLIFIER KIT

This fine amplifier will amaze you with its outstanding performance. It features a true Williamson circuit with extended frequency response, low distortion, and low hum levels. Enjoy true hi-fi with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-Standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extends from 10 CPS to 100 kc within ±1 db at 1 watt assuring you of full coverage of the audio range. Clean, clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms to match the speaker system of your choice. An outstanding performer, this investment will bring you years of listening enjoyment. Shipped express only. Shpg. Wt. 28 lbs.

All basic amplifiers recommended for use with model WA-P2, SP-1 or SP-2 preamplifiers

...When You Buy Heathkits

HEATHKIT

"BOOKSHELF" 12-WATT AMPLIFIER KIT

The model EA-2 combines eye-pleasing style and color with many extra features for high quality sound reproduction. This fine amplifier provides full range frequency response from 20 to 20,000 CPS within ±1 db. Harmonic distortion is less than 1% at full 12 watt output over the entire range (20-20,000 CPS). IM distortion is less than 1.5% at 12 watts with low hum and noise. Miniature tubes are used throughout the advanced circuitry, including EL84 output tubes in a push-pull tapped-screen output circuit using a special designed output transformer. Transformer has taps at 4, 8 and 16 ohms. The model EA-2 has its own built-in preamplifier with provision for three separate inputs, mag phono, crystal phono and tuner. The mag phono input features RIAA equalization. Separate bass and treble controls are provided with boost and cut action. A special hum-balance control assures quiet operation. The luxury styled cabinet has a smooth simulated leather texture in black with inlaid gold design and is constructed of vinyl plastic bonded to steel. It resists scuffing, wear, abrasion, and chemicals. The front panel features brushed-gold trim and buff knobs with gold inserts for a very pleasing appearance. An amber neon pilot lamp indicates when the amplifier is on. Cabinet measures 12½" W. x 3 3/16" D. x 4⅜" H. making it suitable for use on a bookshelf, end table, etc. High quality is emphasized throughout for performance matching amplifiers costing many times more. Shpg. Wt. 15 lbs.

HEATHKIT EA-2 $28.95

Combines beauty, style and quality

★ LESS THAN 1% DISTORTION AT FULL OUTPUT OVER ENTIRE AUDIO RANGE.

★ BUILT-IN PREAMPLIFIER

HEATHKIT A9-C $35.50

A Bargain Package of Power and Performance

HEATHKIT AV-3 $29.95

Invaluable for Hi-Fi Testing

HEATHKIT AW-1 $29.50

Measure Exact Power Output

GENERAL-PURPOSE 20-WATT AMPLIFIER KIT

The A9-C combines a preamplifier, main amplifier and power supply all on one chassis providing a compact unit to fill the need for a good high fidelity amplifier with a moderate cash investment. Designed primarily for home installations, it is also capable of fulfilling P.A. requirements. The preamplifier section features four separate switch selected inputs. Separate bass and treble tone controls offer 15 db boost and cut. A true high fidelity performer, the A9-C covers 20 to 20,000 CPS within ±1 db. Front panel is detachable, and can be installed on the outside of a cabinet where the chassis comes through, for custom installations. A fine unit with which to start your hi-fi system. Shpg. Wt. 23 lbs.

AUDIO VTVM KIT

Critical AC voltage measurements are made easy with this high quality vacuum tube voltmeter which emphasizes stability, broad frequency response and sensitivity. Features large 4½" 200 microampere meter, with increased damping in the meter circuit for stability in low frequency tests. Extremely high voltage range handles measurements from a low value of 1 millivolt to a maximum of 300 volts. AC (RMS) voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 to +52 db. Employs 1% precision multiplier resistors for maximum accuracy. High input impedance (1 megohm at 1,000 CPS). Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

AUDIO WATTMETER KIT

Here is a fine meter to accurately measure output wattage. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w and 50 w full scale. Five switch selected db ranges cover −10 db to +30 db. All indications are read directly on the large 4½" 200 ua meter. Frequency response is ±1 db from 10 CPS to 250 kc. External or internal load resistors are selected with convenient front panel switch. Non-inductive load resistors are built in for 4, 8, 16 or 600 ohms impedance. Precision multiplier resistors are used for high accuracy and incorporates a crystal diode bridge for wide-range frequency response. Modern styling and convenient front panel design. Cabinet is ventilated to allow efficient cooling of load resistors. Shpg. Wt. 7 lbs.

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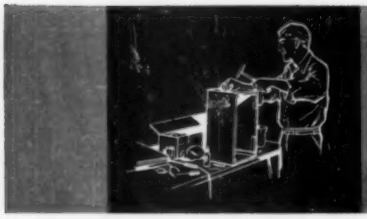
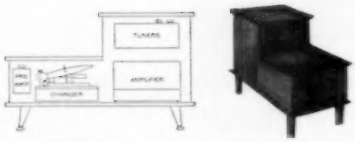


Easy to Buy - Easy to Build - Easy to Use...

HEATHKIT
CE-1
$43.95 each

CONTEMPORARY
Model CE-1B Birch
Model CE-1M Mahogany



TRADITIONAL
Model CE-1T Mahogany

Combine all your Hi-Fi equipment in this attractive cabinet

CHAIRSIDE ENCLOSURE KIT

This Chairside Enclosure lets you combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house the AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit into the space provided. Adequate room is available in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. The enclosure is flexible enough to give you a large choice in component installation. If only one tuner and the preamplifier are used, the two units can be installed in the tilt-out drawer, or if more convenient, either unit can be placed in the space provided in front of the changer compartment. The tilt-out shelf can be installed on either right or left side and the lift-top lid is similarly designed to lift from either side depending on your choice during construction. Good ventilation is achieved through appropriately placed slots in the bottom and back of the enclosure. Overall dimensions are 18"W. x 24" H. x 35½" D. The changer compartment measures 17¾" L. x 16" W. x 9⅝" D. All parts are precut and predrilled for easy assembly and attractive hardware is supplied to match each style. The contemporary cabinet is available in either mahogany or birch and the traditional cabinet is available in mahogany only. Furniture grade plywood can be finished to your taste. Shpg. Wt. 46 lbs.

HEATHKIT AG-9A **$34.50**

Your own source of Hi-Fi audio signals

HEATHKIT AA-1 **$49.95**

3 Audio test instruments in one compact unit

HEATHKIT HD-1 **$49.50**

Check amplifier distortion quickly

AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals from 10 CPS to 100 kc. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1, 3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 CPS. Shpg. Wt. 8 lbs.

AUDIO ANALYZER KIT

Complete high fidelity testing facilities are yours in the AA-1. It combines the functions of three separate instruments; an AC VTVM, audio wattmeter and a complete IM analyzer with filters and high and low frequency oscillators built in. VTVM ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Db scale reads from −65 to +52 dbm. Wattmeter ranges are: .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100% full scale. Provides internal load resistors of 4, 8, 16 or 600 ohms. Combining and consolidating functions reduces the number of test leads and controls required for the same test. Complete instructions are provided for easy assembly, also valuable information on use of instrument. Shpg. Wt. 13 lbs.

HARMONIC DISTORTION METER KIT

Valuable in both designing and servicing of audio circuits, the HD-1 used with an audio signal generator, will accurately measure harmonic distortion at any or all frequencies between 20 and 20,000 CPS. Distortion is read on panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Full scale voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio is measured on a separate meter scale calibrated in db. Features high input impedance (300,000 ohms) and 1% precision resistors in the VTVM voltage divider circuit for excellent sensitivity and accuracy. High quality components insure years of dependable service. Complete instructions provided for easy assembly and operation. Shpg. Wt. 13 lbs.

Heathkits are Your Best Dollar Value

HEATHKIT

TRANSISTOR PORTABLE RADIO KIT

The overwhelming sales of this outstanding transistor portable have made a substantial price reduction possible . . . in addition, an all new plastic molded case adds the finishing touch to the exceptional circuitry. Six name-brand (Texas Instrument) transistors are used for extra good sensitivity and selectivity. The 4" x 6" PM speaker with heavy magnet provides excellent tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned so it is ready for service as soon as construction is completed. A touchup in alignment is easily accomplished on a station by following simple instructions in manual. Alignment tool furnished. Has built-in rod-type antenna for reception in all locations. Six standard size "D" flashlight cells are used for extremely long battery life (between 500 and 1000 hours) and they can be purchased almost anywhere. Cabinet is two-tone blue molded plastic with pull-out carrying handle. Dimensions are 9½" L. x 7¼" H. x 4" D. Shpg. Wt. 6 lbs.

Model XR-1-L: Identical to XR-1-P except in genuine leather case. Rich, warm sun-tan tone. Leather carrying strap included. Shpg. Wt. 7 lbs.

Leather Case: can be purchased separately if desired. Fits all XR-1P's and XR-1's. No. 93-1. Shpg. Wt. 3 lbs. $6.95.

MODEL XR-1-L
$34.95

HEATHKIT XR-1-P **$29.95**

Newly designed plastic case . . . new low price!

★ 4" X 6" SPEAKER FOR "BIG SET" TONE
★ LONG BATTERY LIFE (500 to 1000 Hours)

HEATHKIT CT-1 **$7.95**

Test condensers right in the circuit

HEATHKIT DF-1 **$54.95**

Pin-point your exact location

HEATHKIT FD-1 **$35.95 each**
(6 volt model FD-1-6)
(12 volt model FD-1-12)

Detects gas fumes

HEATHKIT MC-1 **$42.95**

Save your boat batteries

IN-CIRCUIT CAPACI-TESTER KIT

Check most capacitors for "open" or "short" right in the circuit with this handy kit. Detects open capacitors from about 50 mmf up, not shunted by an excessively low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage nor check electrolytic condensers.) Employs a 60-cycle frequency for the short test and a 19 megacycle frequency for the open test. Uses electron beam "eye" tube for quick indication. Test leads included. Shpg. Wt. 5 lbs.

TRANSISTOR RADIO DIRECTION FINDER KIT

This transistor radio compass will double as a portable radio. Covers the standard broadcast band from 540 to 1600 kc. Ideal for use aboard boats and also on land by hunters, hikers, etc. A directional high-Q ferrite antenna rotates from the front panel to obtain a fix on a station. A 1 ma meter serves as null and tuning indicator. Prealigned IF transformers—six transistor circuit. Powered by tiny 9-volt battery with spare included. Dimensions 7½" W. x 5⅜" H. x 5⅛" D. Shpg. Wt. 5 lbs.

FUEL VAPOR DETECTOR KIT

Protect your boat and passengers against fire and explosion with one of these fuel vapor detector kits. Indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot lamp shows when the detector is operating. Easy to build and install, even by one not having previous experience. Operates from your boat battery. The kit is complete with heavy-duty neoprene insulated cable and includes spare detector unit. Shpg. Wt. 4 lbs.

MARINE CONVERTER KIT

Charge 6 or 12 volt batteries with this marine converter and battery charger. A panel mounted 25 ampere meter continuously monitors the charging current. Moisture and fungus proofed for rugged marine use. Convection cooling prevents unsafe temperature rise. The MC-1 has no moving parts, tubes nor blowers to wear out or break. Mounting brackets are supplied for easy installation on any boat. Ideal for keeping batteries fully charged or to supply extra current for appliances, Shpg. Wt. 18 lbs.

HEATH COMPANY • a subsidiary of Daystrom, Inc. • Benton Harbor 20, Mich.

New Styling - New Features...

HEATHKIT TX-1 **$229.50**

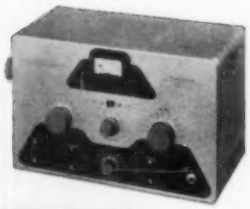
Complete Versatility for Top-Notch Amateur Communications

★ NEWLY DESIGNED VFO—ROTATING SLIDE RULE DIAL
★ MODERN STYLING—PROVISION FOR SSB ADAPTER

"APACHE" HAM TRANSMITTER KIT

Fresh out of the Heath Company laboratories, the brand-new "Apache" model TX-1 ham transmitter features modern styling and the latest in circuitry for extra fine performance. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. These SSB adapters will be available in the near future. A compact, stable and completely redesigned VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters. (11M with crystal control). This unit also has adjustable low level speech clipping and a low distortion modulator stage employing two of the new 6CA7/EL-34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. Shpg. Wt. 107 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.



HEATHKIT DX-20 **$35.95**

An Ideal Code Transmitter

HEATHKIT DX-100 **$189.50**

You'll be Proud to Own This Outstanding Performer

HEATHKIT DX-40 **$64.95**

Phone & CW Facilities at Low Cost

DX-20 CW TRANSMITTER KIT

Designed especially for CW work, the DX-20 features high efficiency at low cost. An ideal rig for the novice or advanced-class CW operator. Plate power input is 50 watts, and covers 80, 40, 20, 15, 11 and 10 meters with single knob bandswitching. Features a single 6DQ6A tube in the final amplifier stage and a 6CL6 as a crystal oscillator. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long service life. Complete shielding to minimize TVI. Removable, metal pull-out plug on left end of cabinet provides access for crystal changing. Very easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

DX-100 PHONE AND CW TRANSMITTER KIT

Well known for its high quality and fine performance the DX-100 features a built-in VFO, modulator, and power supply, complete shielding to minimize TVI, and a pi network coupling to match impedances from 50 to 600 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW, for clean strong signals on all ham bands from 10 to 160 meters. Single knob bandswitching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. High quality components are used throughout, such as potted transformers, silver-plated or solid coin silver switch terminals, aluminum-heat dissipating caps on the final tubes, copper plated chassis, etc. Shpg. Wt. 107 lbs.

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

DX-40 PHONE AND CW TRANSMITTER KIT

An outstanding buy in its power class the DX-40 provides both phone and CW operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 75 watt plate power input on CW, or controlled carrier modulation peaks up to 60 watts for phone operation. Modulator and power supplies are built in and single-knob bandswitching is combined with the pi network output circuit for complete operating convenience. Complete shielding to minimize TVI. Provision is made for three crystals. A four-position switch selects any of the three crystals or a jack for external VFO. Crystal sockets are reached through access door in rear of cabinet. High quality D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.

For Real Ham Enjoyment

HEATHKIT

"MOHAWK" HAM RECEIVER KIT

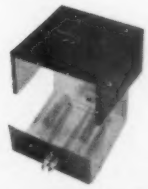
Here is a ham receiver that any radio operator would be proud to own. The "Mohawk" has all the functions required for high quality communications with clear, rock-steady reception on all bands. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all of the amateur frequencies from 160 through 10 meters on seven bands with an extra band calibrated to cover 6 and 2 meters using a converter. Receiver accommodations are provided for these converters which will be available in Heathkits soon. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely preassembled, wired and aligned front end coil assembly assures ease of construction and top performance of the finished unit. Other features include five selectivity positions from 5 kc to 500 CPS, bridged T-notch filter for maximum heterodyne rejection, and a built-in 100 kc crystal calibrator. The set provides a 10 db signal-to-noise ratio at less than 1 microvolt input. Front panel features S meter, separate RF, IF and AF gain controls, T-notch tuning, T-notch depth, ANL, AVC, BFO, bandswitch, tuning, antenna trimmer, calibrate set, calibrate on, CW-SSB-AM, receive-standby, upper-lower sideband, selectivity, phone jack and a wide band rotating slide rule type vernier tuning dial with easy to read calibrations. Shpg. Wt. 67 lbs.

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

HEATHKIT RX-1 **$274.95**

Now in Kit Form a Top Quality Ham Band Receiver

★ PREWIRED AND ALIGNED FRONT END COIL ASSEMBLY.
★ CRYSTAL CONTROLLED OSCILLATORS FOR DRIFT-FREE RECEPTION.



HEATHKIT B-1 **$8.95**

Get Proper Match Between Transmitter and Antenna

HEATHKIT AM-2 **$15.95**

Measure Standing Wave Ratio

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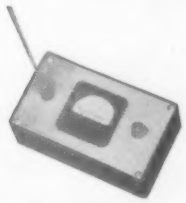

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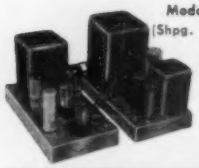

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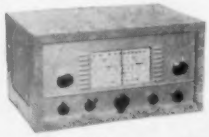

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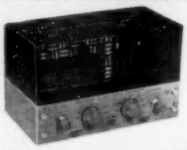

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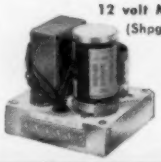

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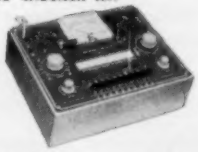

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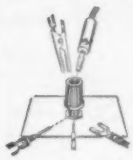

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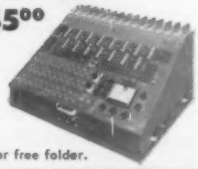

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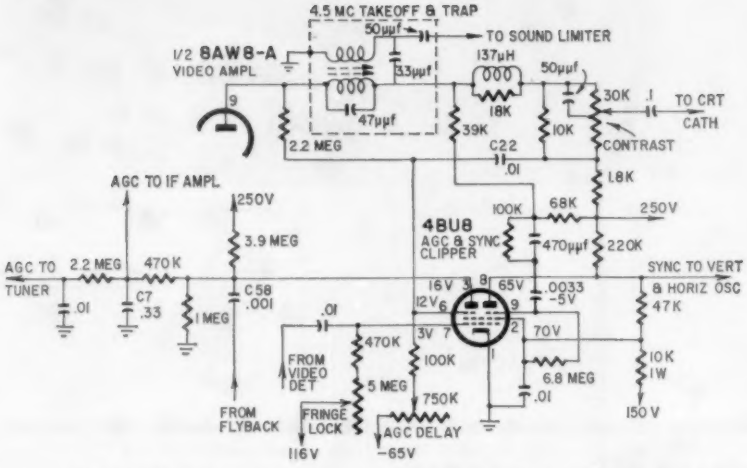


Fig. 1—Keyed agc and noise-inverter circuit in Zenith 15B20 chassis.

(*Continued from page* 61)

6BQ5 is similar to the 6AQ5; 6DK6 similar to 6BZ6. The 6EB8 video amplifier and sound amplifier is similar to the 6AW8. 6CK4 is similar to the 6AH6 and is used in vertical-output stages. The 2CY5, etc. already mentioned are tetrode rf amplifiers. The 6BD5 is used as a vertical output in some Admiral sets. A 12D4 damper is a new tube in the Philco line. Also, the 9BR7, 9-volt equivalent of the 12BR7, is used as phase comparer and sync separator.

Audio FM detectors are almost universally of the gated-beam type first used by Zenith several years ago. Zenith still uses the 6BN6 or its heater variation but the 3DT6 or 6DT6 is still used by most manufacturers in a slightly different circuit and usually with no buzz control. Admiral and Zenith are using neutralized triode first audio if amplifiers. Zenith uses the triode half of a 6BE8, Admiral uses the triode half of a 6AW8.

Keyed agc is in evidence again this year. All but one RCA model has keyed agc and most other manufacturers are using it extensively, especially in their more expensive lines.

Tube and component-saver devices, even in power transformer sets, are more in evidence. RCA's portable, as an example, has B-plus delay until the tube heaters are warm, activated by a resistor-heated bimetal strip in the power transformer's primary circuit.

Keyed-agc—Zenith 15B20

The circuit for keyed agc and noise cancelling used in this set is an interesting and novel combination of these two important functions (see Fig. 1). The tube used for this purpose is a special design, and one half of this dual pentode is also used as a sync separator. Details of circuit action are described in "New TV Tube Does 3 Jobs," RADIO-ELECTRONICS April, 1958, page 102. However, a glance at some of the troubles that can come up in sets using this circuit is helpful.

In this circuit (Fig. 1) the agc is fed to the if through a 470,000-ohm resistor with C7 a 0.33-μf capacitor filtering out horizontal keying pulses and stabilizing the agc. If this capacitor opens, it causes severe bending or tearing due to the introduction of horizontal keying pulses on the agc line, as well as amplified and distorted sync pulses. Partial opening of C7 may cause only poor vertical lock. The agc line should be checked with a scope to determine if it is clean when obscure sync or bending problems occur.

The noise-cancelling portion of this circuit is rather critically biased and has high-impedance circuits. Probably the biggest offender, especially for instability, will be leakage through C22. Leakage through C58 would cause insufficient agc due to the path to ground through the horizontal output transformer.

The Predicta line

As indicated earlier, the Philco (chassis 9L37, 9L38) Predicta line is somewhat revolutionary in design. The circuitry of the 9L37 (picture tube mounted on top of cabinet) is rather conventional but the 9L38 with its remote picture tube has circuitry that will be of special interest to the TV service technician.

Fig. 2 shows the interconnecting cable connections between the chassis and picture tube. The cable is flat, 25 feet long, plugs into the main chassis, and contains 17 wires carrying power, high-voltage, vertical and horizontal deflection current, vertical retrace, remote-speaker wiring, remote-interlock wiring and video. The connectors are round, with a key similar to that of a tube socket.

The video signals are no doubt the most difficult of any of the above to transfer through a cable. Philco has solved this problem by transforming the video to a low impedance, so that capacitance effects are minimized. However, changing video to low impedance is more involved than changing a narrow-band signal.

A circuit that has small frequency discrimination is resistance-matching and is used in the 9L38 Philco chassis as may be noted in Fig. 2. The video is taken off across a 1,000-ohm resistor in the plate circuit of the first video amplifier through a 20-μf capacitor to pass low frequencies and block dc. The opposite end of the line is terminated in a 150-ohm resistor and 10-μh peaking coil and goes directly to the grid of the 3CB6 remote video amplifier, which regains the losses incurred in the impedance match. Unlike most present-day sets, the video is fed to the grid of the picture tube instead of the cathode. This is necessary because of the extra video amplifier, as standard polarity detection is used.

It is interesting to note the minimum number of peaking coils used. There are none in the first video–ampli-

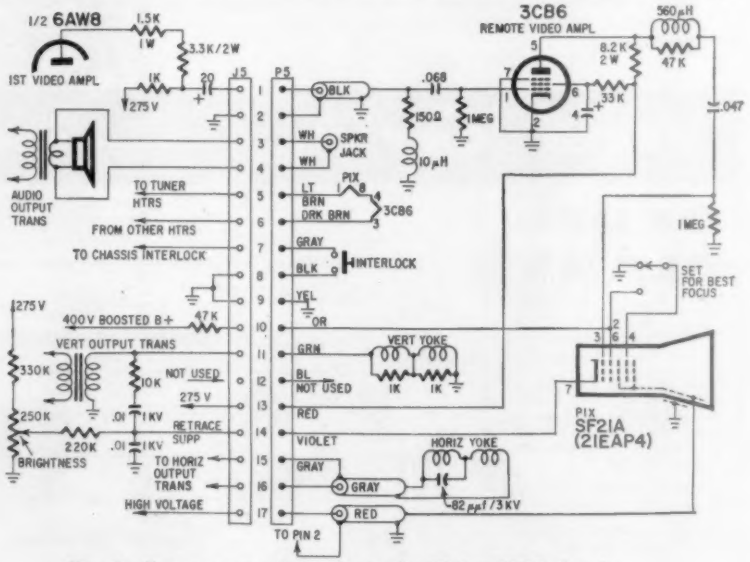
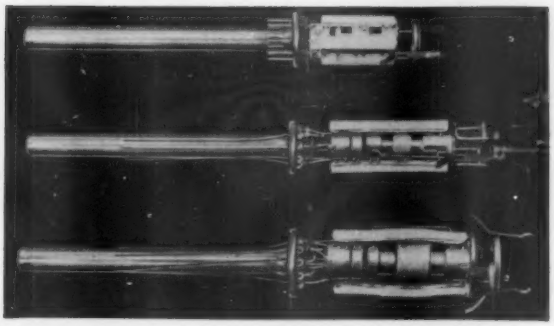


Fig. 2—Interconnected circuits in the Philco 9L38 chassis.



Secret behind the SF 110° picture tube is the short electron gun (top). A Standard 110° gun (center) is ⅞ inch longer. On the bottom is a gun for a 90° tube. The long glass stem connected to the glass base of each unit is removed after the gun is sealed into the picture tube.

Zenith chassis uses a finned power transformer.

fier plate circuit and only one in the second video–amplifier plate circuit. The 4.5-mc sound trap is in the cathode circuit of the first video amplifier.

Back on the chassis of the Philco sets we find a new noise inverter circuit. Fig. 3 is a simplified schematic. The triode inverter (half of a 8AW8) is biased so it is normally nonconducting. Noise that is larger than the

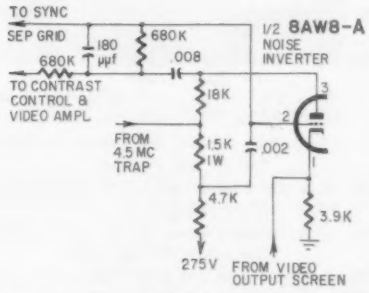


Fig. 3—Philco uses this sync-separator and noise-inverter circuit.

sync pulse tips, however, causes the tube to conduct and the inverted noise pulses appear in the plate circuit which is connected in the normal signal path between the video amplifier. These inverted pulses (negative), therefore, cancel the noise pulses (positive) and the effect is that the sync separator does not see any noise. The inverter is biased from the agc supply and automatically adjusts for changes in signal strength.

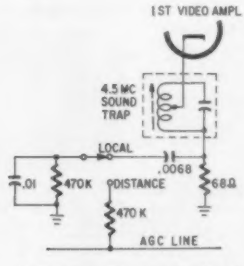


Fig. 4—An interesting variation in local–distance switch design.

An interesting variation, Fig. 4, is the local–distance switch circuit. In the distance position, the agc is lowered by loading it with approximately 1 megohm. This is more or less conventional, but in the local position a .0068-µf capacitor in series with .01 µf and 470,000 ohms in parallel is shunted across the 68-ohm cathode resistor of the first video amplifier. This enhances the high frequencies, giving more detail for local reception. Switching out this network in fringe areas minimizes noise and snow effect in the picture.

One feature of the 9L37 and 9L38 Philco chassis is the slide-out chassis, designed for easier and quicker servicing. The chassis, however, must be slid out from the cabinet for service, *even to replace a tube!* Two chassis-mounting screws must be taken out, the back cover and two chassis brace screws removed, the *Monopole* antenna pulled out, the knobs removed and the chassis pulled out until all tubes are accessible. When reinstalling, take care to fit the chassis guides into their mates in the cabinet at the front or the chassis will not go all the way in. When disconnecting the speaker, note which pins it disconnects from or you may be lost in the maze of identical pins along the printed-circuit board. The speaker pins have heavier black and green wires which will help to identify them.

Summary

All in all, it looks like a better year for the service technician. There is a gradual and welcome disappearance of the multi-unit chassis with special cable connectors or worse yet, none at all. Portables are easier to service, although inherently they will still require patience and tolerance. Audio systems are better, especially on console models. Most of the nonoperating controls are easily accessible and, in general, tube replacement can be made without chassis pulls. In most instances, it appears that the manufacturer has had at least half an ear tilted in the service technician's direction! After all, we service technicians shouldn't ask for too much of a "dream chassis," service-wise . . . we might not be needed at all! END

Suggested by M. Gonzalez

"Wait until you hear it at its *full* volume!"

The Day Before Christmas

By JACK DARR

'TWAS the day before Christmas, and all through the house,
Not a creature was stirring, save me and my spouse.
The gift shopping done, exhausted and broke,
We'd just settled down to wait for *Gunsmoke*.
The TV was purring; the picture was clear,
Not a hint did we have that disaster was near.
When up on the roof there arose such a clatter
I sprang from my chair to see what was the matter.
The picture had faded, the sound was real gone;
I turned to my wife with a face pale and drawn.
"The picture tube's quit us," I cried, all aghast,
"Yet the serviceman promised it had years to last!"
"Don't jump to conclusions," my wife did cry, "Send
For old Mr. Wetzel, our technician friend.
He'll hurry right over, our troubles to end."
She rushed to the telephone, twiddled the dial,
And returned to my side with a face all a-smile.
"He's coming a-running, he promised me so,
To end all our troubles and clear up the snow."
Soon out in the yard there arose such a clatter
That I jumped up again to see what was the matter.
And what to my wondering eyes should appear,
But a wee panel truck heavy-laden with gear,
And a bearded old driver so lively and quick
I knew in a moment it must be Old Nick.
More rapid than eagles his helpers they came,
And he whistled and shouted and called them by name.
"Now, Ollie; now, Freddie; now, Lewis; now, Burke,
Out of the truck now and let's get to work!"
With a crunching and scratching that made me feel faint,
I could hear his long ladders defacing my paint.
"To the top of the porch, to the top of the wall,
Watch out for your balance, be sure not to fall!"
So up the long ladder old Wetzel he flew,
With a belt full of tools and an antenna, too.
And then in a twinkling I heard on the roof,
The crashing and smashing of each monstrous hoof.
(Old Wetzel weighed 200-plus in his skin;
I feared my roof timbers sure would cave in!)
So out in the yard, to watch the debacle,
I dashed to see how the job he would tackle.

Down from the chimney there hung Mr. Wetzel,
And my once-tidy Yagi, bent up like a pretzel!
(To make the thing rhyme, much less to yet sell,
You see why I called on a man named *Wetzel!)*
He yanked off the old one, snapped on the new,
And it seemed in a twinkling to me he was through.
As I went in the house and was turning around,
From the ladder old Wetzel came down with a bound.
He was dressed all in denim, from head to his foot,
And his clothes were all tarnished with ashes and soot.
A bundle of tools he had flung on his back,
He resembled St. Nicholas, with one certain lack.
His eyes they were beady; his dimples? Not merry.
Cheeks not like the roses, but nose like a cherry.
His mean little mouth was drawn up real tight,
And the beard on his chin was a scraggly fright!
A cigar butt was clenched in his few snaggle teeth,
And the smoke made me ill, and faded my wreath.
He had the broad face, and the round little belly,
That shook when he laughed, like that bowlful of jelly.
In his hand was the bill, that jolly old elf,
And I blanched when I saw it, in fear for my pelf.
A wink of his eye and a twist of his head,
Soon gave me to know I had nothing to dread.
He spake not a word, but turned straight to his work.
He checked the TV set, then turned with a jerk.
I looked at the bill: only seventeen-fifty!
Old Wetzel had *changed:* now, he looked rather nifty!
I gave him a smile, a cigar and the cash;
He grinned and was out of the door in a flash.
He sprang to the truck, to his gang gave a whistle,
And away they all flew, like the down of a thistle.
And I heard him exclaim, as they drove out of sight,
"HAPPY CHRISTMAS TO ALL, AND TO ALL A GOOD NIGHT!"
(And the same to you, from all of us!)

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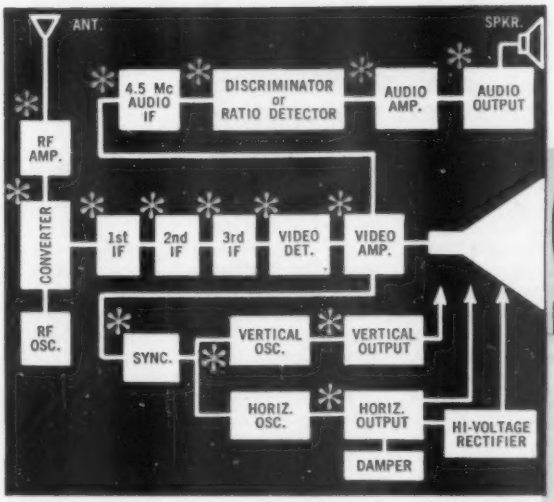

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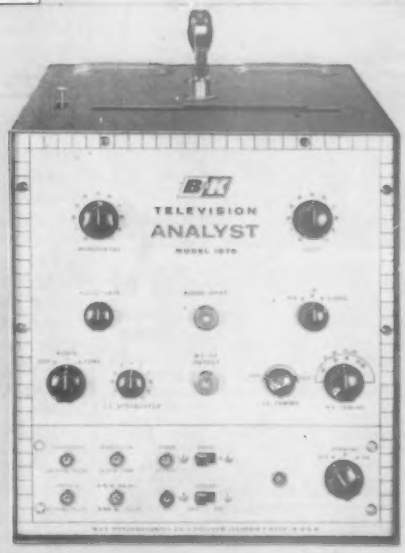

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COLOR Enables you to trouble-shoot and signal trace color circuits in color TV sets.

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Generates full color rainbow pattern of orange, red, magenta, blue, cyan, green to test color sync circuits, check range of hue control, align color demodulators, etc.

SET ADJUSTMENT Enables you to check and adjust the vertical and horizontal linearity, size and aspect ratio of television receivers.

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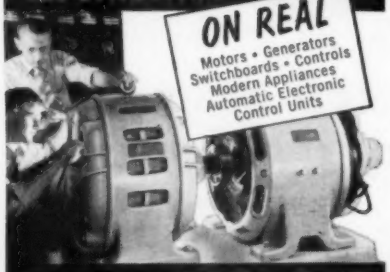

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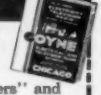

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TECHNICIANS often ask why snow appears in the raster when signal circuits operate at high gain, and how snow signals can be used as quick checks of circuit trouble. These questions are easily answered:

When the receiver is tuned to a vacant channel and contrast and volume controls are turned up, we normally hear a loud rushing noise in the speaker and see flecks of snow in the raster. No snow in the raster, with roaring in the speaker, shows that the picture-signal circuit is weak or dead beyond the sound takeoff point. Snow in the raster, with weak or no rushing sound from the speaker indicates trouble in the sound channel somewhere past the sound takeoff point. Everyone is familiar with this type of test.

These noise voltages have three origins. First, atmospheric and man-made noises are picked up by the antenna. Second, tubes in the signal circuits generate noise from electrons streaming past grid structures. Third, resistors in signal circuits generate thermal noise.

Analysis of snow and noise is based on the fact that all noise voltages are amplified progressively from their point of origin. For example, a given noise voltage applied to the antenna input terminals is greatly amplified, compared to the same noise voltage applied to the if amplifier input.

Levels of noise and snow voltages are ordinarily such that we cannot hear or see their evidence if they originate in circuits past the first if stage. Hence, noise and snow are principally used to check the antenna, rf amplifier, oscillator–mixer and first if stage.

It is helpful to observe the relative snow and noise levels in a normally operating receiver. With the channel selector set to a vacant channel, agc voltage falls to a minimum and signal-circuit gain is maximum. Advancing the contrast and gain controls makes the snow and noise voltages evident.

If the antenna is disconnected and the antenna input terminals are short-circuited, snow and noise should take a big drop. Hence, if the amount of snow and noise is unaffected by this procedure, a faulty antenna or lead-in is indicated. On the other hand, if there is no snow or no noise, or both are missing, with the antenna connected, receiver trouble is indicated.

By progressively unplugging the rf amplifier, oscillator–mixer and first if tubes, we note that the oscillator–mixer contributes the next largest and the rf tube contributes the third largest amount of noise and snow. The if tube contributes the least, and successive if tubes contribute unnoticeable amounts.

If the rf amplifier is weak, the antenna noise is passed (just as a TV signal), but it is not amplified properly. Disconnecting the lead-in causes a noticeable drop in snow and noise but, on the other hand, with the lead-in connected, removing the rf amplifier tube does not cause the usual large drop in snow and noise level.

Further analysis can be made by pulling the rf amplifier and oscillator–mixer tubes in turn, with the lead-in connected. A weak oscillator–mixer stage passes the noise voltages (just as a TV signal), but does not give satisfactory amplification. Thus, a weak oscillator–mixer stage gives less than the normal drop in snow and noise levels when the tube is pulled.

If the raster is quite clear and the speaker practically silent when both the rf amplifier and oscillator-mixer tubes are pulled, the if amplifier has low gain. In a normal receiver, we will get some discernible snow and noise from the first if stage.

Receiver designs must be kept in mind. An if amplifier with three or four if stages can develop more noise and snow at high gain than an if amplifier with one or two stages. Since most receivers have three stages, this variation is not too troublesome. Series-string receivers, of course, must be analyzed by using dummy tubes. Finally, pentode mixers are somewhat noisier than triode mixers. The same observation applies to rf amplifiers.

Intermittent focus

We are servicing an RCA 21CT660U color set. The picture intermittently goes out of focus and shows a wavy scallop down the side, with pulling at the top. Then it snaps back into focus.

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Could the damper circuit cause this trouble?—K. H., Seattle, Wash.

Voltage data should be taken while the intermittent is present. The picture tube could have an intermittent fault, or the trouble may be localized to one of the picture-tube supply circuits. First use a high-voltage dc probe and voltmeter to monitor the 25,000-volt supply to the 21AXP22. See if this voltage "kicks" when the intermittent condition starts. Follow up with dc voltage checks at the focus electrode, screen grids, control grids and cathodes. To distinguish between a defective picture tube and the associated circuits, make the voltage checks with the picture-tube socket removed.

The focus control may be intermittent. If so, replace it and at the same time replace R306 and R276 (470,000 ohms) with 1-megohm 2-watt units to limit focus current and prevent a recurrence of this trouble.

Blowing fuses

I am working on a Sparton 5298, which draws excessive current and blows the fuse. In about 15 seconds the horizontal output tubes get gassy. A high-pitched squeal indicates that the flyback section is working. Circuit measurements do not give much of a clue to the trouble. What would be expected to cause this trouble?—H. W. M., Denver, Colo.

This receiver uses two 6BQ6-GT output tubes in parallel, with 100-ohm parasitic suppression resistors in the grid and plate leads, as shown in Fig. 1. Resistors in pulsed circuits break down faster than in dc and sine-wave circuits. It would be advisable to replace these resistors first, even if they seem OK. Parasitic oscillation will quickly ruin a tube. Also check to see if the tubes are getting enough drive—grid bias should be close to −17 volts. Low drive points to a fault in the 6SN7-GT horizontal multivibrator circuit. A leaky .01-μf coupling capacitor will also cause excessive current drain by pulling down the grid bias. If no raster is obtained, the high-pitched squeal indicates off-frequency squegging. For this trouble, check decou-

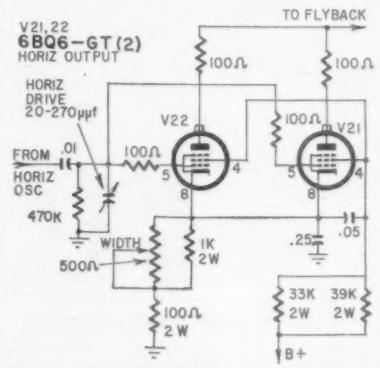

Fig. 1—Faulty 100-ohm parasitic suppression resistors causes early failure of 6BQ6's.

(*Continued to page* 88)

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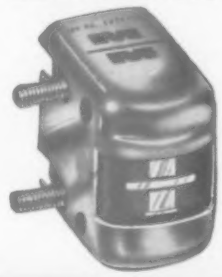

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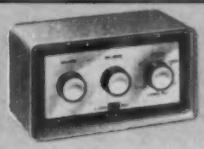

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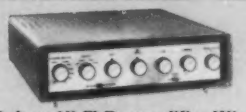

Deluxe Hi-Fi Preamplifier Kit

Quality audio control center. 16 combinations of equalization; 8 inputs including tape head; DC on all tube filaments; printed-circuit switches and boards. Custom-styled. 12½ lbs.

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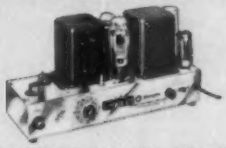

25-Watt Hi-Fi Basic Amplifier Kit

Williamson-type circuit. Response, ±0.5 db, 9-70,000 cps at half power. Includes balance control; calibrated damping control; potted output transformer. Shpg. wt., 25 lbs.

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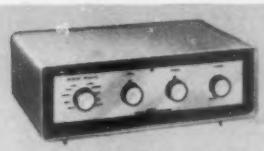

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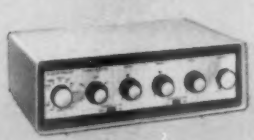

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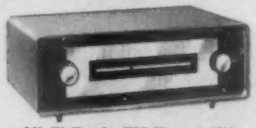

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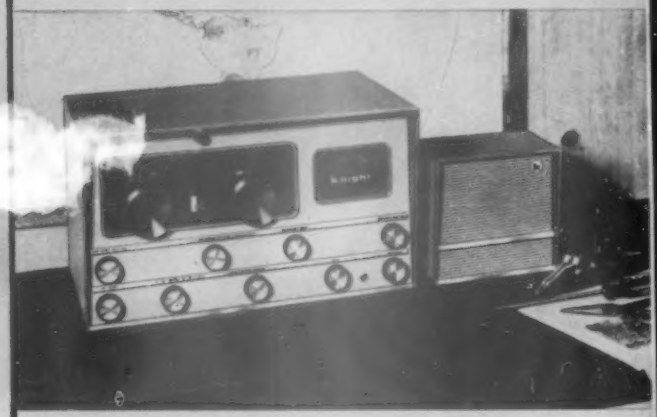

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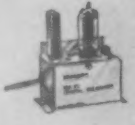

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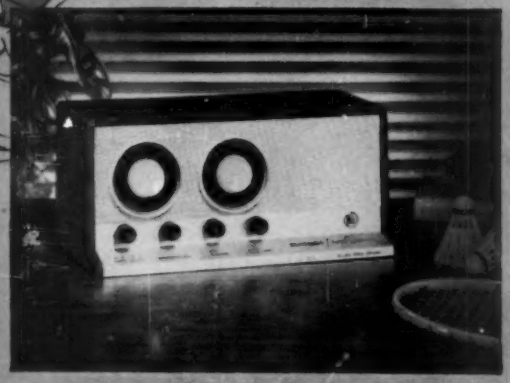

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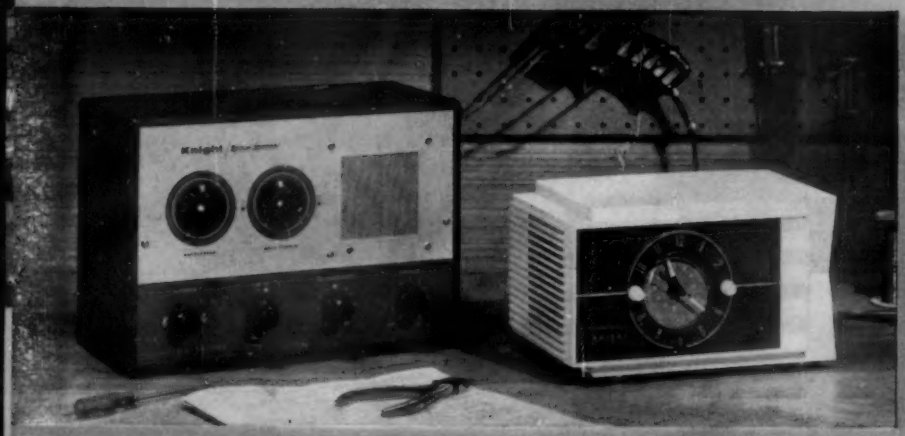

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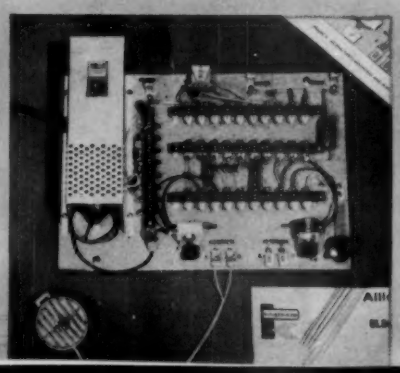

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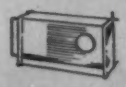

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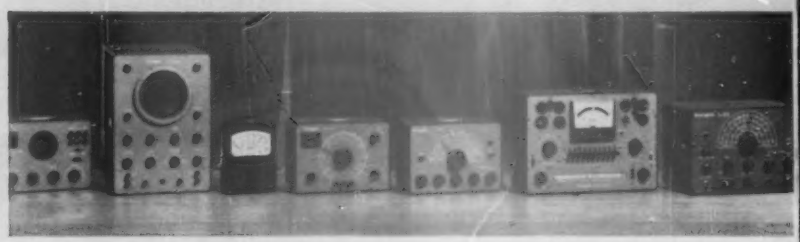

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TELEVISION

(*Continued from page* 83)

pling capacitors in the sweep and oscillator circuits.

Weak channels 5 and 7

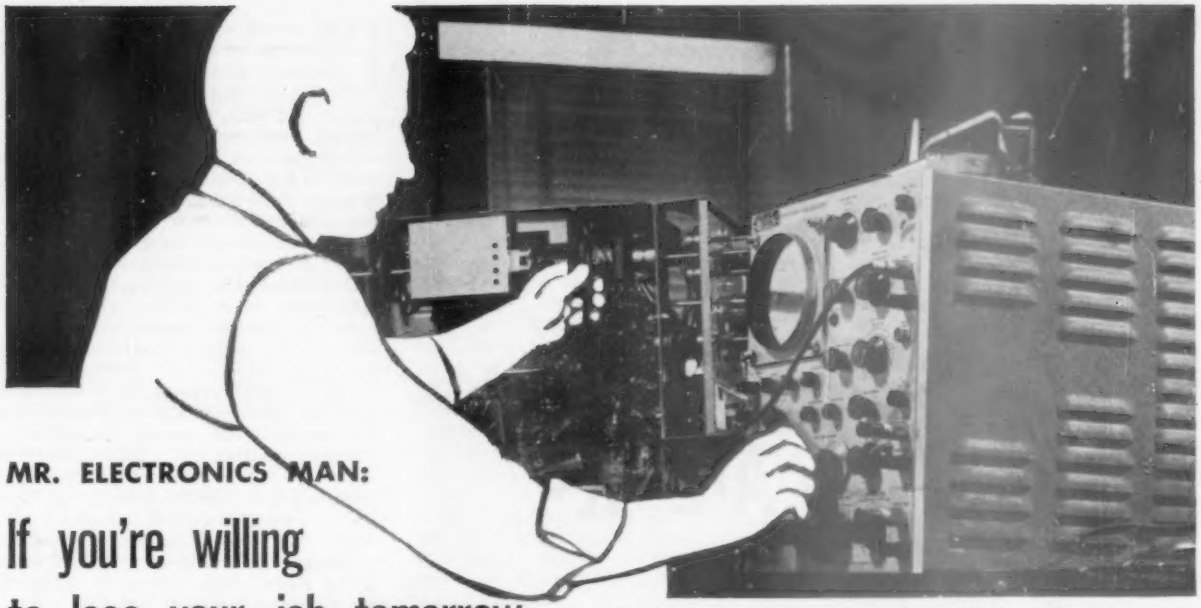
A Motorola TS-531-04 has weak output on channels 5 and 7. The rf stages check out OK. Tuner alignment doesn't help. What can you suggest?—L. J., Evanston, Ill.

Assuming that the tuner has satisfactory output on other channels, there is a defect in the channel 5 and 7 circuits. Your report does not state whether you have checked the oscillator injection voltage and compared it with the injection voltage on the other channels. Weak injection voltage can cause this trouble when the tuner checks out OK otherwise. Check at the mixer grid with a vtvm. Normal voltage is about −2. If low, check for poor oscillator switch contacts in the 5 and 7 positions. Also, make certain that the oscillator is operating on frequency.

Burned-out flyback

An Emerson 697, series B, came into the shop with the flyback burned out, 6CD6 envelope shattered and its cathode resistor burned out. After repair, the receiver operates but the flyback overheats badly. Raster lines on left third of the screen are slightly wavy. The flyback is an exact replacement. What can you suggest?—W. S., Saco, Me.

The overheating, of course, is caused by too much current flow through the flyback. This could be caused by a leaky coupling capacitor in the 6CD6 grid, a shorted cathode bypass capacitor or off-value screen and cathode resistors. It would be advisable to recheck these points. Excessive current flow can also be caused by low drive to the 6CD6 grid. The minimum allowable drive voltage cannot be stated definitely, not being given in the service data. Check the plate supply to the horizontal oscillator. This should be 170 volts. Check the resistances of the decoupling resistors to the 6SN7 oscillator tube—they may have increased in value. If the raster is a bit narrow, this would indicate lack of adequate drive voltage. The ringing in the raster can be caused by off-value or defective capacitors in the yoke circuit or by a minor defect in the horizontal oscillator circuit. Because waveform data is not given, running this down will be mostly a trial-and-error procedure. END



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RADIO for WEEKEND SAILORS

By LEO G. SANDS

Part II—A closeup of some of the equipment you may have to repair and a few maintenance hints

LAST month we discussed the fundamentals of marine radio and what is needed to break into the repair end of this growing field. This month we will take a look at some typical equipment you will encounter.

Most marine radiotelephones have a tunable AM broadcast band in addition to fixed-tuned communications channels. Some higher-powered sets do not have built-in broadcast reception facilities, which may not be desirable in commercial applications. Instead, an external AM tuner, which can be installed at a more convenient location, may be used, utilizing the audio system of the radiotelephone.

The typical marine radiotelephone has a minimum of external controls and indicators. These usually consist of a volume control, a channel-selector switch, a squelch control (if the set is equipped with squelch), a tuning knob for the broadcast-band tuner (if provided), an on–off switch, a power-on indicator, a transmitter-on indicator and a push-to-talk button on the handset or microphone.

All makes and models of marine radiotelephones which meet FCC requirements are essentially similar. They differ in quality of performance, manufacture and components as well as in

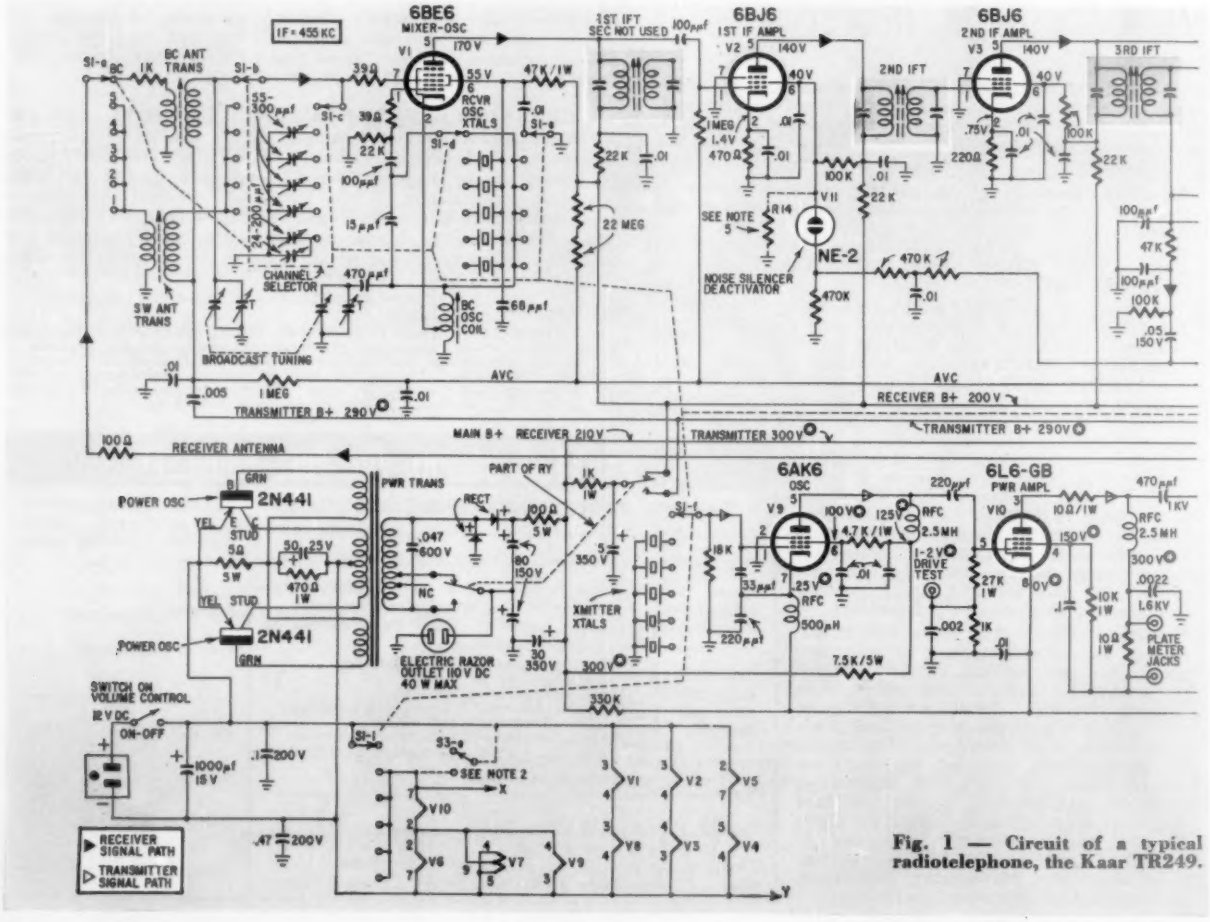


Fig. 1 — Circuit of a typical radiotelephone, the Kaar TR249.

styling and electrical and mechanical design. They range in power rating (input to final rf amplifier) from 20 to 150 watts.

The Kaar 249 marine radiotelephone, shown schematically in Fig. 1, has been selected for design and circuit analysis because of its wide range of application and because it incorporates so many new features. While small enough and sufficiently low in cost to be desired by the typical weekend sailor, the man with an outboard runabout, it can also be used on larger boats.

The Kaar 249 weighs only 15 pounds and measures only 5½ inches in depth, 10 inches in width and 14 inches in height. It is generally mounted vertically with the control panel at the top. Because of its so-called slim-line design, it protrudes very little when fitted vertically against a bulkhead or the back of a seat, and as its center of gravity is close to its mounting it will not tear loose, even when waters are choppy.

The set fits into a mounting plate permanently attached to the boat. The set is fastened tight with four thumb screws. The mounting plate may be attached so that the set is either vertical, horizontal or upside down—under the dash, suspended from the ceiling, behind the cockpit, against the bulkhead or on a table.

The set may be removed from its mounting and suspended from a clip in a reverse position so the bottom of the chassis faces outward. This permits easy servicing on the boat.

The control panel has a five-channel selector switch, a broadcast-band tuning knob, volume control, on–off switch, antenna current indicator lamp and a pin jack for the antenna connection. External connections are made at the rear of the chassis through a quick-disconnect plug. The microphone cable connects to screw terminals at the rear of the chassis. A multicontact jack is added if quick-disconnect of the mike is desired or if a remote control is used.

The aluminum cabinet is designed for ample ventilation, yet is splash-proof.

To conserve battery drain, transmitter tube heaters are turned off when the set is used for AM broadcast reception. When used for reception or monitoring on a communications channel, the transmitter tubes are on ready to operate when the press-to-talk button is actuated.

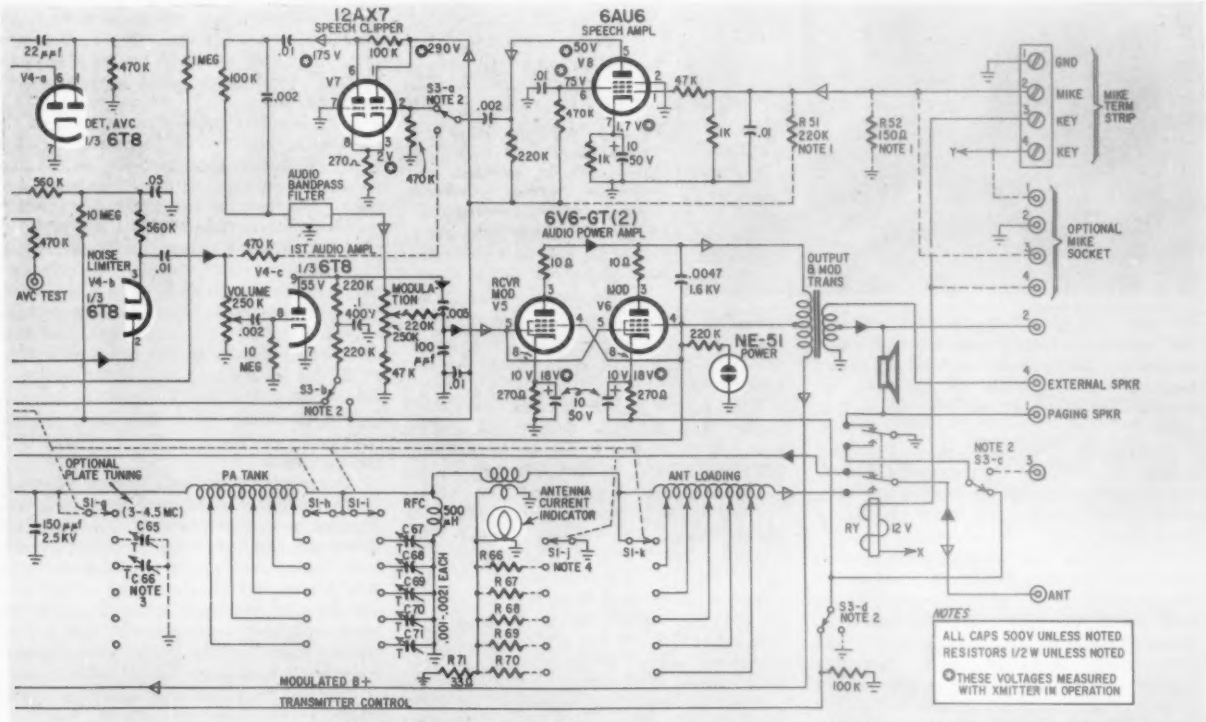
The transistor power supply functions even when the battery is extremely low. The relay which handles the transmit–receive changeover functions pulls in even when battery voltage is down to 8 from its normal 12 volts. This means that the set will usually work even when the boat's battery has been idle for a considerable time.

Current drain is small. With a 12-volt input, the receiver alone draws 2.5 amperes. In stand-by position the set uses 3.4 amperes and when transmitting total drain is only 9 amperes.

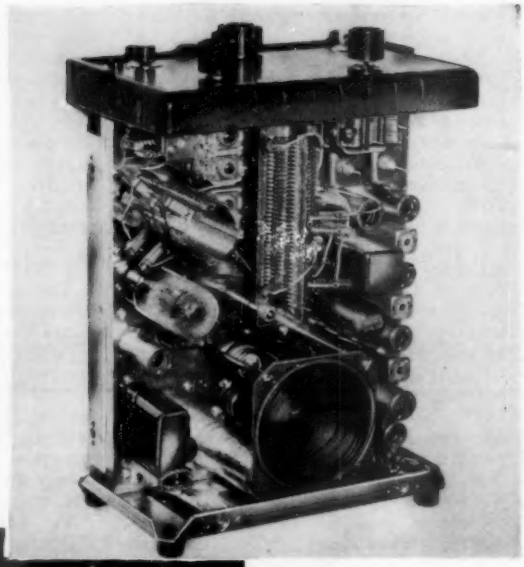
The transmitter and receiver

The transmitter delivers 10 watts into a 10-ohm 200-$\mu\mu$f antenna with 20 watts power input to the final rf amplifier. It is capable of 100% modulation. Overmodulation is prevented by a speech clipper, and speech clarity is maintained and radiated bandwidth confined to legal limits by an audio bandpass filter, the audio response being sharply attenuated above 3 kc (26 db down at 4 kc).

The transmitter output, intended to match a 10-ohm antenna, is fed to the antenna through a pi-output network which attenuates harmonics and spurious radiations by at least 60 db. As shown in Fig. 2, a simplified schematic, L1 is the final rf amplifier tank coil. It is isolated from the dc plate voltage by C1 and tuned to resonance by adjusting



[1]Resistors R51 and R52 are added for operation with a carbon microphone.
[2]Switch S3 (optional) is added for operation as a paging amplifier. The switch is shown in the normal operating position.
[3]Capacitors C65 and C66 may be added for a vernier adjustment of the power amplifier tank circuit.
[4]Resistor R71 may be removed and resistors R66 through R70 added as required to produce proper illumination of the antenna current indicator for each channel.
[5]Resistor R14 may be added to raise the signal level required to disable the noise silencer. Value may range from 1 megohm to 100,000 ohms.



Top chassis view of the Kaar 249. The power transistors used in the power supply section are under the speaker.

Hung on its own mounting plate with the bottom of the chassis facing out, this radiotelephone is easy to service.

its slug and C2. Capacitor C3 controls the amount of coupling and bypasses harmonics to ground. L2 is a tapped loading coil, adjusted to resonate the antenna at the desired operating frequency.

Individual trimmers are provided across C2 and C3 for each channel so the transmitter can be tuned for optimum performance at each operating frequency.

The receiver is a single-conversion superhet. Its sensitivity is 5 μv at 6-db signal-to-noise ratio. Bandwidth is 8 kc ±6db. An automatically disabling series-impulse type noise silencer irons out noise impulses and provides squelch action by reducing the audio output when no signals are being received. It also reduces noise between stations when tuning through the broadcast band.

Noise limiter

Fig. 3 shows the detector circuit and weak-signal noise limiter used in some marine receivers. R6, R7, R8, C4 and C5 comprise the diode load and filtering network of the diode detector. The detector's audio output must go through the noise-limiter diode to reach the volume control.

The audio signal is also developed across R9 and the diode, the signal passing from the junction of R7 and R8 through C6. Under ordinary signal conditions the cathode of the noise-limiter diode is more negative than its plate because the voltage divider consisting of R10 and R11 is fed from a more highly negative point of the detector diode load than the plate. The noise-limiter diode then conducts and, because of its very low resistance, allows the audio signal to develop across volume control R12.

Because the time constant of R10 and C2 is relatively large, a short-duration high-amplitude noise pulse causes the plate of the noise-limiter diode to swing negative, making it stop conducting momentarily, thus preventing the noise pulse from getting through to the volume control R12. In this way noise pulses are removed from weak signals. When the signal is weak, neon lamp NE does not conduct and may be disregarded.

When a strong signal is received, the receiver gain is reduced by avc action and the signal overrides any noise pulses present. However, the noise limiter must be automatically disabled because audio pulses reaching the limiter diode will produce distortion. The noise limiter is disabled by the neon lamp. One side of the lamp is supplied with B plus from the screen grid of the first if amplifier controlled by the avc line.

Avc action increases the grid bias on the if amplifier and reduces the screen current and increases the screen voltage. The neon lamp conducts and applies a positive voltage to the plate of the noise-limiter diode to swamp out any audio pulses that may reach it. R1 and C1 form a low-pass filter which reduces transients when the neon lamp starts to conduct.

Antenna systems

The typical boat antenna is a center-loaded vertical whip. It is resonated to the highest frequency at which it is to be used. When the transmitter is switched to lower frequencies, bottom loading for resonating the antenna is provided automatically within the transmitter.

On large boats, vertical or horizontal wire antennas are often used. But, the vertical center-loaded whip is the most popular. For outboard boats, new lightweight antennas are making their appearance.

The ground connection, a part of the antenna system, is the most critical part of the entire installation. Unless a really effective ground connection is provided, much of the transmitter's power will be wasted. By referring to Fig. 4, it may be noted how this waste can occur. R_r is the radiation resistance of the antenna which is in series with R_L, which represents antenna losses due to skin effect and leakage, and with R_g, which is the ground resistance.

If R_r is 4 ohms, R_L 1.15 ohms and R_g 5 ohms, the load on the transmitter is 10.15 ohms. But only 40% of the power is getting into the antenna, 60% being wasted.

Losses (R_L) in the antenna itself are a matter of design and materials and cannot be reduced to zero. The installer, however, can do something about ground resistance. Actual physical contact with the water, while desirable, is not necessary. In the case of a fast-moving outboard, a ground plate on the bottom of the hull might not always be in contact with the water.

Instead, all of the heavier metal

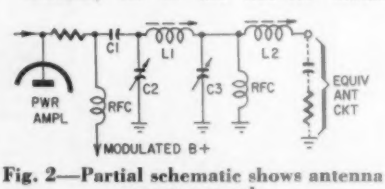


Fig. 2—Partial schematic shows antenna output network.

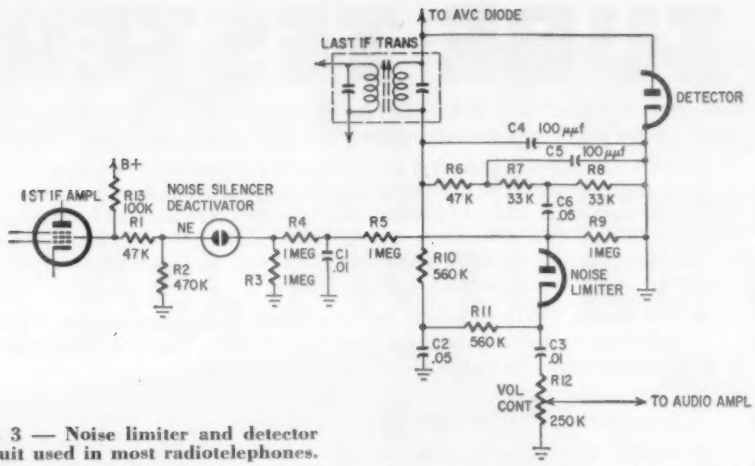


Fig. 3 — Noise limiter and detector circuit used in most radiotelephones.

devices on a boat should be bonded together electrically. In a boat with an inboard motor, the engine, gas tank, water tank, sink, stove and other metal objects of any size can be bonded together. In an outboard job, contact should be made with the motor, perhaps through a short jumper strap from the bonding strap.

Wire is *not* as satisfactory for bonding as a wide copper or brass strip. Thickness is not important, but width is. The strap should be at least 3 inches wide. It may be cemented or tacked or otherwise fastened to the boat structure. Contact with the objects being bonded must be positive to avoid erratic contact, a possible source of noise.

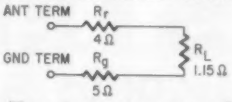


Fig. 4—How improper grounding can reduce a transmitter's output.

The bond strap is then brought to the chassis of the radiotelephone. If possible, it should be fastened securely to the chassis itself. However, this is often unfeasible so the strap is brought as close to the set as possible and then a wire jumper connects it to the set's ground terminal. For the Kaar 249 and any other set which fits into a mounting plate, the ground strap can be terminated at the plate. It is important to keep the ground-lead short, particularly between the set and the first large metal object it contacts. In essence, the ground system acts as a counterpoise or ground plane for the antenna.

Besides enabling the more efficient transfer of energy from the transmitter to the antenna system, a low-impedance ground connection reduces and sometimes eliminates ignition-noise problems.

While noise silencers in modern marine radiotelephone cut out some of the ignition noise, the usual treatment should be given any inboard motor. This includes installing capacitors at the generator and distributor. A suppressor at the distributor is usually a must, and often spark-plug suppressors are necessary. In rare cases, the ignition wiring may have to be shielded completely.

Preventive maintenance

Since marine radio is a safety device, it must be reliable. Reliability can be increased by aging tubes before they are placed in service. An aging rack can be easily made.

Moisture, salt spray and heat are enemies of electronic equipment. To reduce damage from salt spray many manufacturers treat metal parts with special chemicals. When sets are brought in for servicing or storage, they should be thoroughly cleaned.

An accumulated film on the surfaces of component parts can retard natural cooling. Dirt on the tank coils and capacitor plates may introduce losses. Because of the skin effect, rf flows on the surface of the wire. If a film is formed, part of the current may flow through the film, which is a poorer conductor than the wire and hence adds resistance to the circuit. This film also contributes to losses due to lowering of shunt resistance.

The future

There are some 65,000 transmitters licensed for marine use. But there are more than 7,000,000 boats, and new boats are being manufactured at a record rate. Thus it is obvious that there is a big market for marine electronic gear.

Until recently, the weekend sailor had to do without the safety and convenience of radio because the available equipment was too big and too expensive.

Now, the radio industry is meeting the demand for small-boat radiotelephones with new, lower-cost equipment. The missing link, however, is the shortage of technically qualified dealers to sell as well as install and service radiotelephones for these growing numbers of weekend sailors.

And, it is during the present "off season"—this fall, winter and spring—that the existing and prospective marine electronics dealers make their plans for the 1959 "on season," which promises to be a dilly. END

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A new popular priced sound amplifier series . . . Available in 10, 20, 30 and 60 watt models for every indoor, outdoor and mobile application. Quality-built, with every desired feature, for top performance and extensive coverage. Provides complete flexibility in any combination from one amplifier to complete sound systems.
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SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11 — TUBE TESTER . . . Total Price $47.50 — Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months.

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type..

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

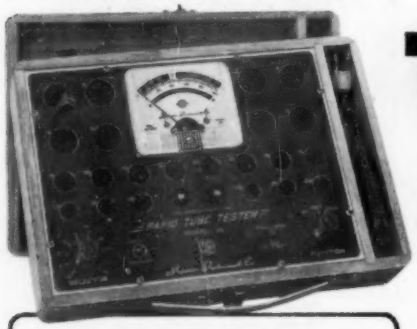
The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$47.50 NET

SUPERIOR'S NEW MODEL 82

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!



Model 82 — TUBE TESTER . . . Total Price $36.50 — Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months.

(1) **Turn the filament selector switch to position specified.** (2) **Insert tube into a numbered socket as designated on our chart (over 600 types included).** (3) **Press down the quality button —**

THAT'S ALL! Read emission quality direct on bad-good meter scale.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82 will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82 the noval is duplicated eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch—THAT'S ALL! Read quality on meter. Inter-element leakage, if any indicates automatically.

- Tests over 600 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82 comes complete, housed in portable, hand-rubbed oak cabinet with removable cover. Only

$36.50 NET

SHIPPED ON APPROVAL

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Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

SEE PAGE 97 FOR COMPLETE DETAILS

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

Model 83 — C.R.T. TUBE TESTER . . . Total Price $38.50 — Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months.

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes— in the carton— out of the carton—in the set!

The Problem:

Required, a tester—housed in a single carrying case capable of testing and rejuvenating *all* picture tubes including black and white and color; 50 degree, 90 degree or 110 degree. A tester capable of testing these ever increasing types speedily and efficiently. A tester capable of proving to the satisfaction of the set owner that the picture tube is definitely good, bad or weak. To do so the serviceman must be able to instantly switch from the comparative simple testing of a black and white tube to the complex requirements for testing each individual section in a tri-gun color tube.

The Solution:

The Model 83 more than meets the requirements specified above. It will not only test every type of picture tube ever made but will test them for leakage, emission and gas content. Furthermore even if the tube tests "good" Model 83 will help you to predict the length of time the tube will remain "good." The Model 83 will also enable you to extend the useful life of a "weak" tube by *properly controlled* application of rejuvenating voltage.

Specifications:

- Model 83 is *not* simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides *separate* filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

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MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Model 77 — VACUUM TUBE VOLTMETER... Total Price $42.50 — Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months.

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only **$42.50 NET**

SUPERIOR'S NEW MODEL 79

The Most Versatile All-Purpose Multi-Range Tester Ever Designed!

SUPER-METER

WITH NEW 6" FULL-VIEW METER

Model 79 — SUPER-METER... Total Price $38.50 — Terms: $8.50 after 10 day trial, then $6.00 per month for 5 months.

A Combination **VOLT-OHM MILLIAMMETER.**
Plus **CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS.**
Also Tests **SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES**

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development.

In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Specifications

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: 001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: −6 to +18, +14 to +38, +34 to +58.

The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. **All Germanium Diodes.**
All Silicon Rectifiers. **All Silicon Diodes.**

Model 79 comes complete with operating instructions and test leads. Use it on the bench—use it on calls. A streamlined carrying case included at no extra charge accommodates the tester, instruction book and test leads.... Only **$38.50 NET**

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See following page for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL TV-50A GENOMETER

7 Signal Generators in One!

- ✓ R.F. Signal Generator for A.M.
- ✓ R.F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

Model TV-50A GENOMETER . . . Total Price $47.50 — Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months.

Specifications

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency).

The Model TV-50A comes complete with shielded leads and operating instructions. Only

$47.50 NET

For the first time ever: ONE TESTER PROVIDES ALL THE SERVICES LISTED BELOW!

SUPERIOR'S NEW MODEL 76 ALL PURPOSE BRIDGE

Model 76 . . . Total Price $26.95 — Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months.

IT'S A CONDENSER BRIDGE

with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A SIGNAL TRACER

which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

CAPACITY BRIDGE SECTION

4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

SIGNAL TRACER SECTION

With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

IT'S A RESISTANCE BRIDGE

with a range of 100 ohms to 5 megohms

IT'S A TV ANTENNA TESTER

The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

RESISTANCE BRIDGE SECTION

2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

TV ANTENNA TESTER SECTION

Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only

$26.95 NET

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MOSS ELECTRONIC, INC.
Dept. B-542, 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligation.

Name .....

Address .....

City ..... Zone ..... State .....

All prices net, F.O.B., N. Y. C.

- ☐ Model TW-11 ..... Total Price $47.50
  $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 82 ..... Total Price $36.50
  $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 83 ..... Total Price $38.50
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 77 ..... Total Price $42.50
  $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 79 ..... Total Price $38.50
  $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model TV-50A ..... Total Price $47.50
  $14.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 76 ..... Total Price $26.95
  $6.95 within 10 days. Balance $5.00 monthly for 4 months.

Prewired and aligned front end, coupled with a circuit that can be precisely aligned without using a signal generator, puts this kit in competition with ready-to-use communications receivers

MOHAWK... a communications receiver kit

By
JOHN T. FRYE, W9EGV

A COUPLE of years ago I was asked if I thought a really high-grade communications receiver could be assembled from a kit. My answer was, "No." I felt it would be most difficult for an untrained person to handle the very critical wiring of a band-switching, high-frequency front end. Then, too, precise alignment without a good signal generator and other specialized equipment seemed next to impossible.

The Heath Co. has served up a large dish of crow with their new Mohawk model RX-1 receiver, and I am eating it. But I insist they did not play fair. One objection was bypassed by furnishing an assembled and completely aligned front end. The other was circumvented by working out an if alignment method that is as ingenious as it is foolproof. Several features of this receiver should be interesting, not only to amateurs and ham-band listeners, but also to alert service technicians who realize that "radio" embraces a lot more that the circuitry of an ac–dc receiver and who also know that the broadcast receiver of the future may be a single-sideband receiver.

The Mohawk is shipped in three boxes. One contains the preformed metal cabinet; another the carefully protected front end containing the tubes with which it was aligned, and the third about a bushel basket of parts ranging from the husky potted power transformer down to tiny knob setscrews. Step-by-step instructions, pictures, wiring diagrams, pictorial drawings and detail sketches all combine to make the assembly and wiring as easy and mistake-proof as possible, but putting this receiver together is still a long way from a brief evening's work. Despite considerable experience in electronic construction and kit assembly, it took 32 actual working hours—spread over almost a week—to build the Mohawk.

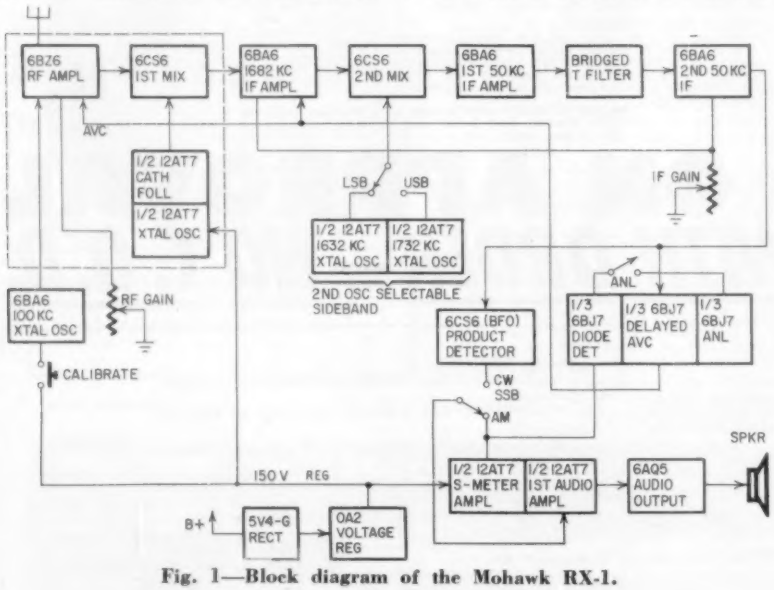


Fig. 1—Block diagram of the Mohawk RX-1.

The Mohawk has obviously been designed to provide optimum reception of the 160-, 80-, 40-, 20-, 15-, 11- and 10-meter amateur bands *under present-day conditions.* Even a casual listener to these bands must be impressed with two facts: the bands are very crowded and are becoming more so each day; single-sideband suppressed-carrier emission is steadily gaining in popularity. Consequently, many of the receiver's features are aimed at coping with interference and making the tuning of SSB stations easier.

A study of the block diagram in Fig. 1 and the circuit diagram in Fig. 2 reveals the receiver's salient features. It is a double-conversion superheterodyne with crystal-controlled second-conversion oscillators and a choice of a conventional detector for AM reception or a "product detector" for CW and SSB reception. Plate voltages of the first conversion oscillator, bfo and S-meter amplifier are voltage-regulated. A series type noise limiter is provided, and delayed avc provides maximum signal-to-noise ratio—claimed to be 10 db at less than 1-μv input—on weak signals. A 100-kc marker generator is included and it is used with a panel-mounted CALIBRATE control—a

Sylvania consumer advertising points out—

The big difference in Picture Tubes!

Take it from Bill Shipley: "'Silver Screen 85' consumer advertising makes it easy to *sell-up* to 'first line' picture tubes."

New TV Campaign dramatizes test results . . . *sells consumers up* to "first line" picture tubes . . . builds more profitable sales and satisfied customers for dealers everywhere.

Sylvania's fabulous new family, "The Real McCoys," is one of the top new television shows of the season. Critics label it the "Sleeper of the Year." Week after week, on the "Real McCoys" Sylvania is making millions of set owners aware of the big difference in picture tubes as revealed by direct comparisons of a nationwide sample of cut-rate off-brand picture tubes against Silver Screen 85 standards.

New commercials like the "Brightness Test" are pre-selling consumers on the "first line" performance of Silver Screen 85.

For dealers everywhere it means more and more customers asking for "Silver Screen 85"—Pre-sold customers make satisfied customers—strengthening your business reputation and building long-range profitable growth.

Sylvania has designed this powerful new selling tool for you. Get behind it and *sell-up* to "first line" Silver Screen 85 picture tubes.

Highlights of Sylvania's TV "Brightness Test."

"Don't be fooled by picture tubes that look alike — they don't act alike."

Sylvania's Silver Screen 85 is over twice as bright as this "off-brand" tube.

"Insist on a nationally known 'Silver Screen 85'—there's one to fit every make TV."

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING • TELEVISION • RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

trimmer capacitor across a section of the oscillator coil—to set the pointer exactly on frequency on any band. Separate rf, if and af gain controls make for great flexibility. A bridged-T notch filter with 50 db of attenuation can be tuned through the 50-kc if passband.

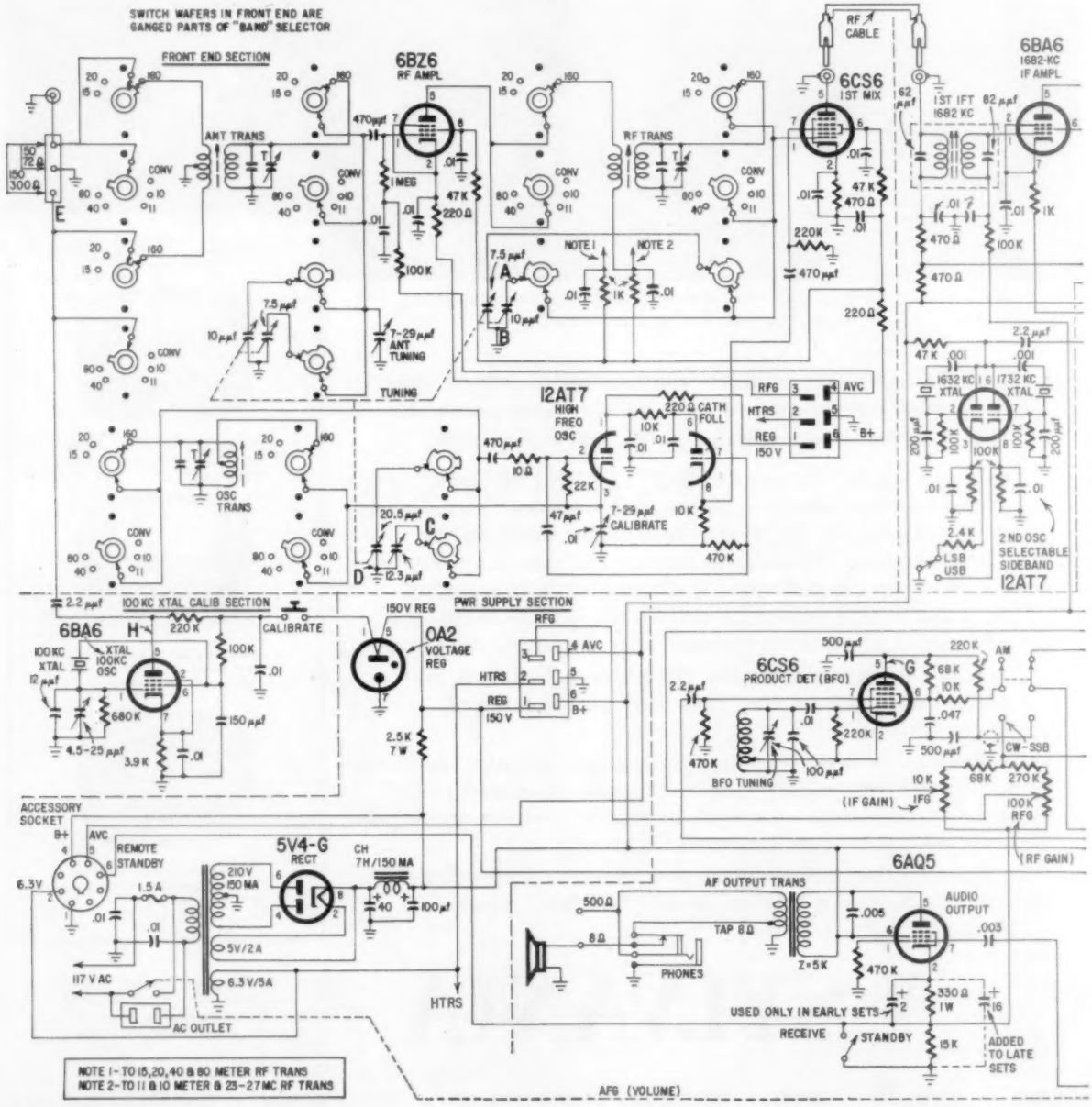
Interference protection

The double-conversion circuit protects against two kinds of interference. Images are always a problem on a high-frequency receiver using a low intermediate frequency. When a receiver with a 455-kc if is tuned to 1000 kc, the oscillator is set to 1455 kc to produce the required 455-kc difference frequency. A station on 1910 kc is also 455 kc away from the oscillator and, unless it is greatly attenuated by the tuned stages ahead of the mixer, it is received along with the 1000-kc station being tuned. However, since the image station in this example is almost 100% higher in frequency that the desired station, images give little trouble on the broadcast band. But when the receiver is tuned to 29 mc the image frequency is at 29.951 mc, roughly only 3% higher, and the tuned circuits cannot provide enough attenuation to reject a strong image station.

By using a first intermediate frequency of 1682 kc, the Mohawk places the image frequency more than 3 mc away from the desired signal, banishing image trouble. However, it is very difficult to get high gain and stability together with good adjacent-channel selectivity with a high if. Converting the 1682-kc frequency to a low if—here approximately 50 kc—solves this problem and gives the RX-1 both excellent image rejection and razor-sharp adjacent-channel selectivity.

As a further aid to combatting interference, the Mohawk is intended to receive only one sideband at a time, even of an AM station. Since the information contained in both sidebands is identical, this is quite feasible and has advantages mentioned later. Study Fig. 3 to see how this sideband selection is accomplished.

Suppose we want to receive a signal on 4000 kc that is modulated with a 1,000-cycle signal, producing sidebands of 3,999 and 4001 kc as shown in Fig. 3-a. The difference between the oscilla-



tor frequency, 5682 kc, and the carrier with its two sidebands produces the frequencies shown in Fig. 3-b at the mixer output. Note that the position of the upper and lower sidebands has been reversed. The upper sideband (USB) is on 1681 kc and the lower sideband at 1683 kc. When this signal reaches the second mixer, it combines with the signal from one of the two crystal-controlled oscillators.

If the 1632-kc oscillator is used, we have the situation of Fig. 3-c in which the upper sideband is converted to 49 kc and falls outside the passband, the carrier becomes 50 kc and falls on the low-frequency slope, and the lower sideband (LSB) becomes 51 kc and falls squarely in the passband.

Now suppose the 1732-kc oscillator is used. The difference frequency between this and the carrier is still 50 kc, placing the carrier on the low-frequency slope again. But now the difference between the 1681-kc USB and the 1732-kc oscillator is 51 kc, making it fall in the passband, while the LSB is converted to 49 kc and rejected. The desired sideband is selected by flipping the switch that actuates one or the other of the two crystal oscillators. Often, interference from an adjacent station can be lost simply by flipping over to the sideband farthest from the station.

The diagram of the prewired and aligned front end has been simplified in Fig. 2 by eliminating all coils except those for the 160-meter band. The main tuning capacitor has six sections —two each in the rf amplifier, mixer and oscillator circuits. In each circuit, the capacitor sections are used singly or in parallel to provide proper band coverage. In the rf amplifier plate circuit one B-plus decoupling network is used for the 80-, 40-, 20- and 15-meter bands and another when operating on 160, 11 or 10 meters and in the 23–27-mc range when using external converters.

The if strips

The first if amplifier operating at 1682 kc minimizes image interference. It is a 6BA6 with its gain controlled automatically by delayed avc applied to its grid and manually by varying the cathode bias.

As mentioned, most of the adjacent-

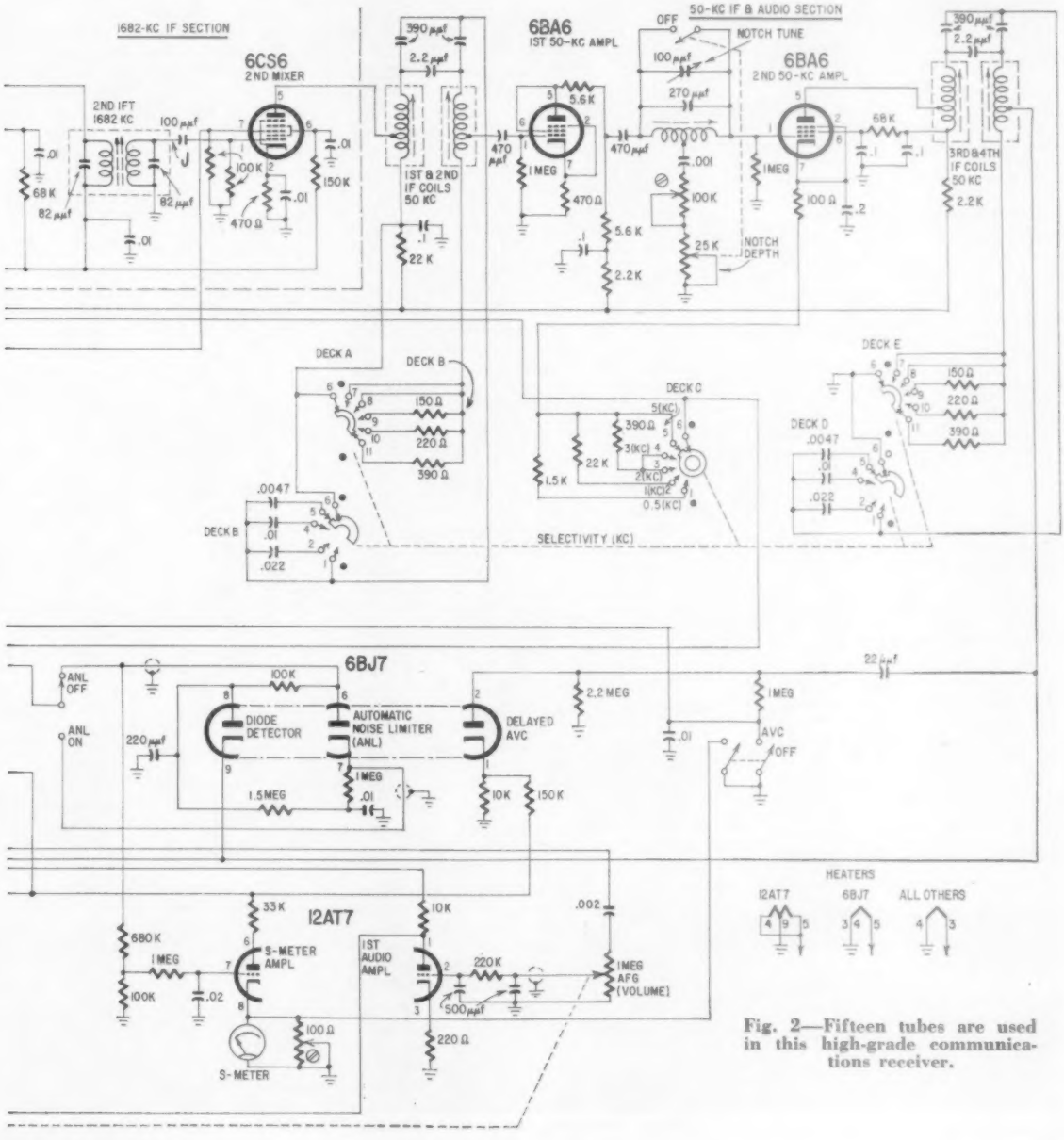


Fig. 2—Fifteen tubes are used in this high-grade communications receiver.

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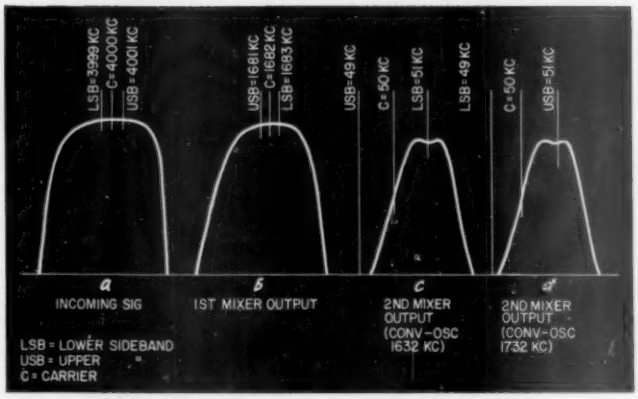

Fig. 3—Side-band selection in the Mohawk.

channel selectivity is provided by the 50-kc if amplifier. This amplifier's passband can be set at bandwidths of 5, 3, 2, 1, or 0.5 kc with the SELECTIVITY switch. The method of doing this is not new. I have seen simple versions of it used in some of the fine broadcast receivers brought out in the '30's, and it is also used in some other communication receivers; but it is one of those intriguing things that is interesting in theory and works beautifully in practice.

Since the two tuned-circuit sections of the if strip are similar, let's study the one between the 6CS6 second mixer and the 6BA6 if amplifier. First, note the if coils are *coils*, not transformers. Each shield can contains a single coil as shown in Fig. 2, and the coupling between coils is entirely capacitive. In the 500-cycle (0.5) passband position, the junction of the two 390-$\mu\mu$f capacitors is grounded through the 0.1-μf plate decoupling capacitor, and the total signal transfer is through the 2.2-$\mu\mu$f capacitor connecting the hot ends of the two coils. All series resistance is switched out of the second tuned circuit by deck A of the SELECTIVITY switch. As this switch is moved to wider and wider bandwidth positions, decreasing amounts of capacitance are switched between the junction of the two 390-$\mu\mu$f units and ground. This increasing reactance lifts the junction of the two capacitors higher and higher above ground and permits more and more signal to be transferred through them in addition to that transferred through the 2.2-$\mu\mu$f unit. At the same time, deck A switches increasing amounts of resistance in series with the tuned circuit of the second coil, lowering its Q. Increased coupling and decreased Q of the second coil combine to widen the passband.

When the junction of the two 390-$\mu\mu$f capacitors is grounded, each coil is tuned simply by its associated 390-$\mu\mu$f unit. But as capacitance is introduced between the junction and ground, each coill is tuned by the series combination of its individual 390-$\mu\mu$f unit and this shared capacitance. Since the switched capacitance decreases as the bandwidth is increased, the center resonant frequency of the coils goes up with increasing bandwidth, as shown in Fig. 4. This lets the low-frequency skirt of the passband, the one on which the carrier is normally placed, to stay at essentially the same position while the high-frequency skirt moves up to accommodate the wider passband. It is not necessary to retune when changing bandwidth. Deck C of the SELECTIVITY switch cut different amounts of resistance into the cathode circuit of the second 50-kc if tube to maintain the gain of the if strip relatively constant for all bandwidth positions.

The bridged-T notch filter shown between the first and second 50-kc if tubes provides an extremely sharp tunable notch that can be moved through the if passband to give 50–60-db attenuation of the signal to which it is tuned while frequencies on either side of the notch frequency are only slightly affected. Fig. 5 shows how this operates. When the notch is placed on the frequency of a station causing an annoying heterodyne, the heterodyne disappears as if by magic. Incidentally, if the notch is accidentally placed on the frequency of the station being received, it will disappear by the same magic. Of course only one signal can be notched out at a time, and for effective notching the signal cut out must be a few hundred cycles away from the desired carrier. A broad signal covering a band of frequencies cannot be notched out.

Single sideband

All the features that contribute to stability and sharp selectivity aid in SSB reception. The heavy construction (the aluminum panel is a full ⅛ inch thick), the guarding of the first conversion oscillator against pulling by feeding it into the mixer through a cathode follower stage, the 30-to-1 gear ratio of the tuning dial and provision for removing every bit of backlash and slop in this dial assembly, the clever arrangement that locks the dial shaft positively and automatically at each end of the pointer travel so that no calibration-upsetting strain can be carelessly placed on the tuning assembly, are all very important when

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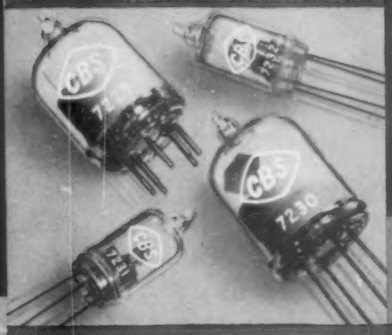

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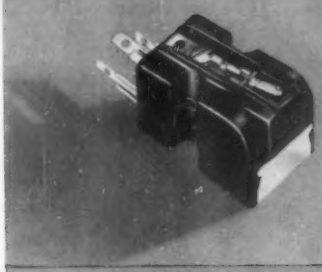

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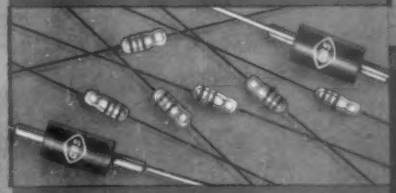

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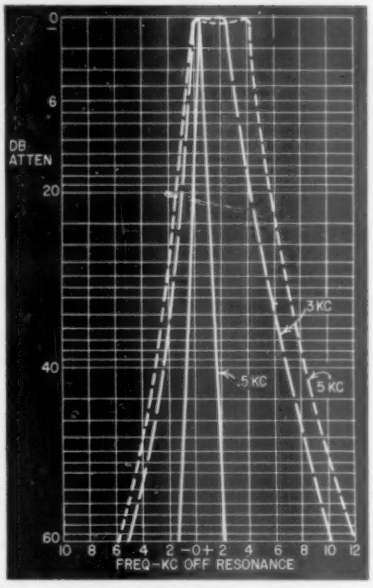

Fig. 4—Typical response curves of the 50-kc if amplifier with the selectivity switch set to the 0.5-, 3-, and 5-kc bandwidth positions.

you consider that the receiver must be tuned to within 10 cycles of the exact transmitter frequency, even at 29 mc, if the SSB station is not to sound distorted. And it must stay on that frequency.

The 6CS6 converter, or product detector, contributes a great deal to the ease of SSB reception. A portion of the tube serves as the bfo operating at 47–53 kc, and the output of this oscillator is mixed with the signal delivered from the 50-kc if strip. The output of the 6CS6 contains the combination of the two signals. For CW, the combination becomes the audio-frequency beat or difference frequency. When the incoming signal is SSB, the bfo supplies the carrier that has been suppressed.

This converter detector has one important advantage over the conventional diode type for SSB reception. With a conventional receiver, rf gain has to be greatly reduced so the comparatively weak bfo signal can simulate the missing carrier. Received signals of different strength call for adjusting the rf gain control to maintain a proper proportion between the SSB signal and the injected carrier. With the Mohawk, the rf and if gain controls can be turned full up and the avc can be left on when receiving either CW or SSB stations. Strong SSB signals will sound somewhat louder than weak ones, but they are no more intelligible.

Alignment is easy

But probably you are wondering how a complicated receiver such as this can be aligned without a signal generator.

First you must adjust the 100-kc crystal oscillator to precisely 100 kc. The receiver does not normally tune

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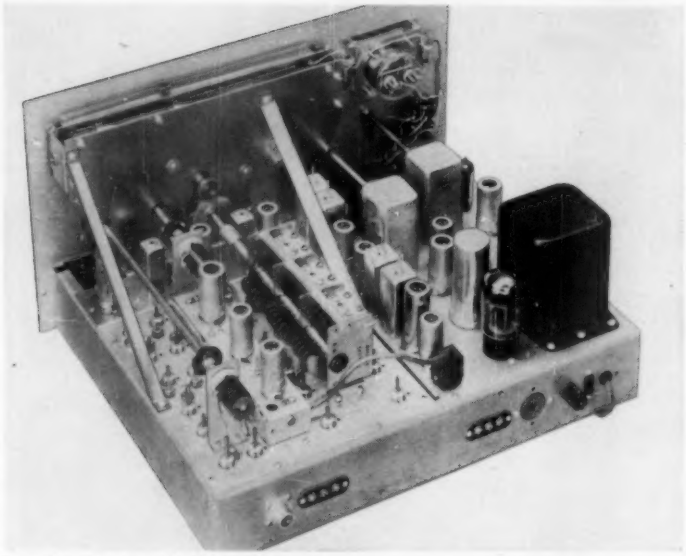
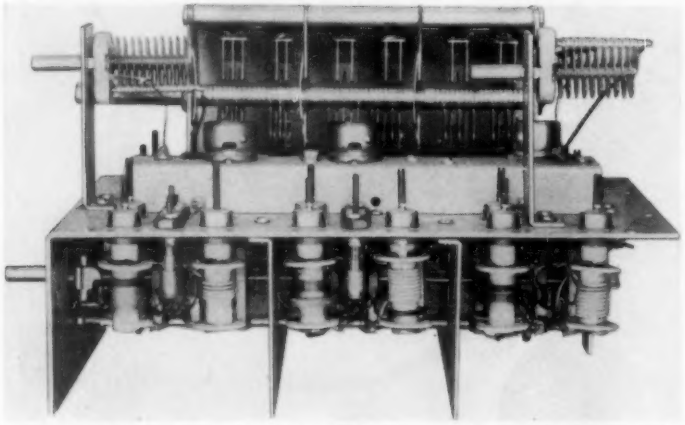
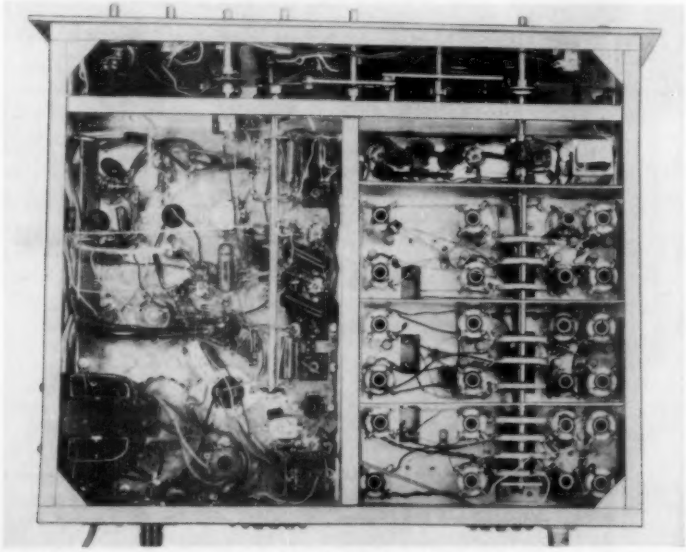


Top-chassis view of the receiver.



The assembled, completely aligned front end furnished with the kit.



Detailed instructions make this wiring job almost easy.

10 mc, but two compression type preset capacitors are furnished. When one of these is connected between points A and B of Fig. 2 and the other between points C and D and the receiver is set to the 20-meter band, the oscillator and mixer circuits are padded so they will reach down to 10 mc. A temporary jumper between points A and E couples the output of the 100-kc oscillator into the mixer, and an antenna is connected to point A. Now when WWV is tuned in and the push-button switch that activates the 100-kc crystal oscillator is depressed, the two signals combine and produce a heterodyne in the speaker. The 4.5–25-$\mu\mu$f capacitor in the oscillator circuit is adjusted so that the 100th harmonic of the crystal oscillator is in exact zero beat with WWV. This sets the crystal oscillator very precisely on 100 kc.

The next step is to set the bfo to 50 kc. The padder capacitors and jumper are removed, the first 50-kc if tube is taken out of the socket and one of the trimmer capacitors is connected between points H and G. This connects the output of the crystal oscillator to the converter detector so that any difference in frequency between the 100-kc oscillator and the second harmonic of the bfo will produce an audible beat. With the bfo dial set to 50 kc, the slug in the bfo coil is adjusted to exact zero beat. Then the bfo dial is moved to a mark on the panel that represents a frequency of 50.4 kc, producing a 400-cycle note in the speaker. The four 50-kc coils are actually peaked at 50.4 kc.

This is done by connecting the trimmer between points G and J. This connects the output of the bfo to the input of the 50-kc if strip. With the bfo operating and the SELECTIVITY switch in the 0.5-kc bandwidth position, the slugs of the four if coils are adjusted for maximum S-meter swing. While the coils tune sharply, the sensitive S-meter makes it easy to set the coils right on the nose.

Now comes the adjustment of the 1682-kc if transformers. Consider this: the 50-kc strip in the sharp position will accept only a 50-kc signal. The 1632- and 1732-kc crystal oscillators will operate only at their exact crystal frequencies. Therefore, the signal delivered to the second mixer must be precisely 1682 kc for it to beat with either crystal oscillator and produce the 50-kc difference frequency that results in maximum S-meter swing. So it is necessary only to tune in one of the harmonics of the 100-kc crystal oscillator and then align the 1682-kc if transformers for maximum S-meter swing. It is as simple as that!

All that is left to do is to set the coil in the notch filter. First you tune in a harmonic of the 100-kc oscillator and adjust for zero beat with the BFO set exactly at 50 kc. Set the NOTCH TUNE dial at 50 kc. Adjust the slug in the coil for minimum S-meter reading,

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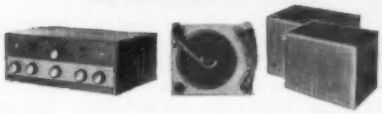

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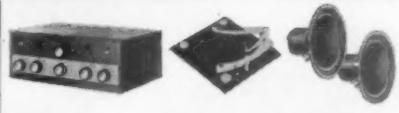

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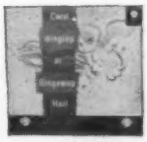

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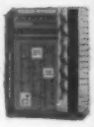

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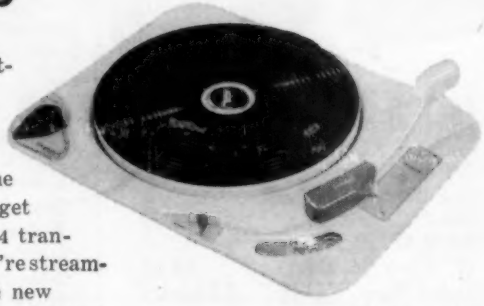

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HI-FI COMPONENTS • LIGHTERS
SPRING-POWERED SHAVERS
MUSIC BOXES

NEW HYDE PARK, NEW YORK

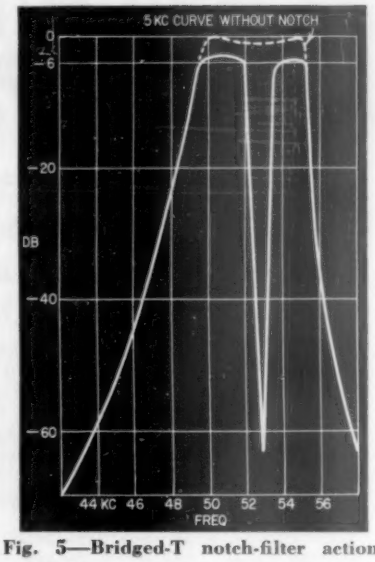


Fig. 5—Bridged-T notch-filter action.

indicating that the notch is right on the carrier. Finally, adjust the 100,000-ohm variable resistor in the notch circuit for minimum S-meter reading.

There is an eighth band (CONV) on the dial calibrated 50–54 and 144–148 mc. When this is switched in, coils in the receiver's front end tune from 23–27 mc. Two- and 6-meter converters will use this tuning range to provide reception on these bands.

As might be expected, hams are already busy second-guessing the experts and are making changes they consider improvements. One I know has carefully turned the 1/16-inch-wide pointer edgeways so that he can split kilocycles on that long dial. Another has removed the 2-μf 50-volt capacitor between the cathode of the audio output tube and the junction of the 330-ohm and 15,000-ohm resistors and has substituted a 16-μf 150-volt capacitor between the cathode and ground. He claims this gets rid of the fairly loud thump in the speaker you get when the receiver is switched from STANDBY to RECEIVE. (This change has been made in late-production models and is shown on the diagram.—*Editor*) Personally, I am contemplating replacing the 100,000-ohm resistor in the voltage-dividing network supplying avc voltage to the S-meter amplifier with a linear 100,000-ohm variable unit, the 1-megohm resistor being attached to the slider. This keeps the "S-9 equals 100 μv" calibration of the S-meter on the high-frequency bands, but also cools off the S-meter's sensitivity on the low-frequency bands where it reads too high for my taste.

These innovations point up a significant characteristic of owning a Mohawk. Even though the receiver is a precision instrument that will perform with the best of them, after you have put it together and aligned it with your own hands, it loses that dare-not-touch familiarity between you and the receiver you have built. END

Gifts that really get jobs done!

Weller®

POWER TOOLS

Each one designed for professional results and made to the same high quality standards as the famous Weller Soldering Guns.

New WELLER SOLDERING GUN Value

A *must* for radio, TV and hi-fi work, this Weller Soldering Gun also makes anyone an expert on scores of household repairs. Heats instantly. Fingertip "on-off" control. Twin spotlights. Unmatched for quick, easy, accurate soldering.

$5.95 MODEL 8100

Weller professional soldering gun models are also available for all requirements.

Work-Saving WELLER POWER SANDER

$16.95 MODEL 700

Eliminates tiresome hand sanding. Removes old paint, sands wood smooth in a jiffy. Power-packed with 14,400 strokes a minute. Fingertip "on-off" control. Sandpaper and polishing cloth included.

Also available in kit with metal case, $18.95 MODEL 700K

Twice the sanding area of any sander in its price class . . . 25 sq. inches.

Versatile WELLER SABRE SAW

Makes every kind of cut in plywood, composition board, plastics, aluminum, etc. Ideal for everything from making valances to doing household repairs. Exclusive strain-relief design eliminates blade breakage. Lubricated for life. 3 different blades included.

$19.95 MODEL 8CO

All Weller Power Tools are guaranteed for 1 year

Order now from your Electronic Parts Distributor.

WELLER ELECTRIC CORPORATION, EASTON, PA.

NO OTHER TUBE TESTER MADE- AT ANY PRICE-can MATCH the VALUE of the CENTURY FAST-CHECK

SIZE:
H: 11¼"
W: 14⅜"
D: 4¾"

20,000 SERVICEMEN CAN'T BE WRONG!

See for yourself—AT NO RISK—why over 20,000 servicemen selected the FAST-CHECK above all other tube testers—regardless of price. With the FAST-CHECK you will make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

Model FC-2—housed in sturdy wood carrying case complete with CRT adapter . . . only

Guaranteed for One Full Year

$69.50 Net

Special compartment accommodates line cord and Picture Tube Test Adapter

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes. This feature eliminates the need of carrying extra instruments and makes the FC-2 truly an all-around tube tester.

FAST-CHECK'S low price is made possible because you are buying direct from the manufacturer.

Just 2 settings on the

FAST-CHECK TUBE TESTER

tests over 650 tube types completely, accurately — AND IN SECONDS!

- **POSITIVELY CANNOT BECOME OBSOLETE** Circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.
- **NO TIME CONSUMING MULTIPLE SWITCHING** Only two settings are required instead of banks of switches on conventional testers.
- **NO ANNOYING ROLL CHART CHECKING** Tube chart listing over 650 tube types is conveniently located inside FAST-CHECK cover. New tube listings are easily added without costly roll chart replacement.

COMPARE FAST-CHECK WITH OTHER TESTERS RANGING FROM $40 TO $200

RANGE OF OPERATION

- ✓ Checks quality of over 650 tube types, which cover more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes, OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✓ Checks for inter-element shorts and leakage.
- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

IMPORTANT FEATURES

● Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale ● Less than 10 seconds required to test any tube ● 41 long lasting phosphor-bronze tube sockets accommodate all present and future tube types . . . cannot become obsolete ● 7-pin and 9-pin straighteners mounted on panel ● Large D'Arsonval type meter is extremely sensitive yet rugged — fully protected against accidental burn-out ● Special scale on meter for low current tubes ● New tube listings furnished periodically at no cost ● Compensation for line voltage variation.

Other testers may have some of the above features . . . but only the FAST-CHECK has them all!

SHIPPED ON APPROVAL FOR 10 DAY FREE TRIAL

Try the FC-2 before you buy it! No obligation to buy.

PAY IN SMALL MONTHLY PAYMENTS

Easy to buy if you're satisfied. Pay at net cash price . . . no financing charges.

NO MONEY REQUIRED WITH ORDER . . .

CENTURY ELECTRONICS CO., INC.

Dept. 112, 111 Roosevelt Ave., Mineola, N. Y.

Rush the FAST-CHECK for a 10 day trial period. If not completely satisfied I will return the instrument within 10 days without further obligation. If fully satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. No financing charges are to be added.

Model FC-2 . . . $69.50 — Pay $14.50 within 10 days. Balance $11.00 monthly for 5 months.

Name.....

Address.....

City..... State.....

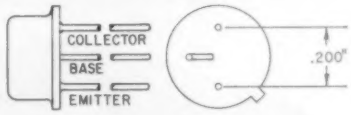
F.O.B., Mineola, N.Y.

NEW TUBES and SEMICONDUCTORS

SEMICONDUCTORS have taken over this month's column, presenting a variety of transistors, diodes and photoconductive cells. There is a group of medium-power transistors for amplifying and switching, a 600-mc oscillator and an audio power-output transistor. Also mentioned are a germanium photojunction cell, some Zener diodes, DAP transistors and cadmium sulfide and cadmium selenide photoconductive cells.

2N524, 2N525, 2N526, 2N527

A group of p-n-p alloy-junction transistors for low- to medium-power amplifier and switching applications at frequencies up to 100 kc.



2N524, 2N525, 2N526, 2N527

Maximum ratings of these General Electric germanium transistors at 25°C are:

V_{CB}	45
V_{CE}	30
V_{EB}	15
I_C (ma)	500
P_{total} (mw)	225

Electrical characteristics at 25°C (typical ratings listed) are:

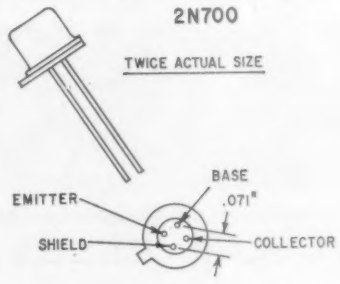
	2N524	-525	-526	-527
f_{ab} (mc) (V_C=5 common base, I_E=1 ma)	2	2.5	3	3.3
h_{FE} (V_{CE}=1, I_C=20 ma)	35	52	73	91
NF (db) (f=1 kc)	6	6	6	6

2N700

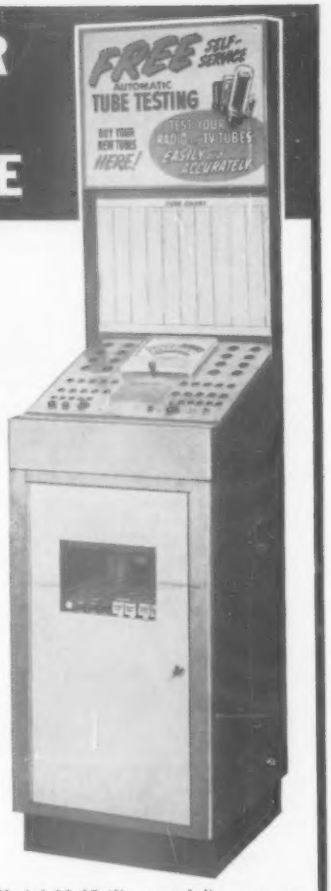
This Mesa transistor is a germanium p-n-p diffused-junction unit capable of

2N700

TWICE ACTUAL SIZE



THIS SELF-SERVICE TUBE TESTER IS YOUR STEPPING-STONE TO A BRIGHT NEW PROSPEROUS FUTURE



EARN BIG MONEY AND ACHIEVE FINANCIAL STABILITY

If you've ever longed for a business of your own . . . to be your own boss and to work your own hours, then here's your opportunity to get in on one of today's biggest money-making opportunities — *the self-service tube testing business.* It's the easiest business to get into . . . requires no experience, little time and small investment.

A basic principle for making money is to have something work for you, rather than you yourself doing the work. As an operator of a FAST-CHECK SELF-SERVICE TUBE TESTER ROUTE you can be the proud owner of a solid fast-growing business . . . earning money while you take life easy. Business can be started without giving up your present source of income and can be operated from home. All you do is make calls once a week to restock testers and collect profits.

WHAT IS THE SELF-SERVICE TUBE TESTING BUSINESS?

The self-service tube testing business is a take-off on the highly profitable vending machine business . . . Drug stores, luncheonettes, supermarkets, etc. welcome having a tube tester placed in their store. You place testers and tube stock in stores on consignment — the store location contributes floor space for the self-service tube tester — store patrons are offered the use of the tube tester free — they in turn buy their replacement tubes from the tube stock in the tester. The store pays you for all the tubes sold less his commission. Each tester placed can net up to $1000 a year for you.

NO SELLING REQUIRED

Century's self-service tube testers check and sell TV and radio tubes automatically 12 hours a day — 7 days a week. Consumers do their own testing and defective tubes are replaced on the spot for highly profitable sales. *Your testers are your high powered salesmen.*

MANUFACTURER-TO-YOU PRICES

Since we are the manufacturers and sell direct to you, we have been able to price the FAST-CHECKS so low that they represent the greatest value in testers available. Our unusually low prices enable you to place more units with less investment.

FAST-CHECK SPECIFICATIONS

- 46 long lasting phosphor-bronze sockets accommodate all present and future tube types — cannot become obsolete.
- Attractive red and hammer-tone gray durable metal cabinet. Takes only 19" x 19" of floor space.
- Tube compartment with own lock holds 400 or more tubes.
- Removable tube storage trays with specially designed dividers separate tube cartons — make it easy to restock tubes that are sold.
- Large seven inch easy to read meter is extremely sensitive yet rugged — is fully protected against accidental burn-out.
- Completely self-service — easy to operate.
- Built-in 7-pin and 9-pin straighteners on panel for customers convenience.
- Quick reference tube chart lists over 650 tube types — conveniently mounted.
- A colorful illuminated point-of-sale display tops the cabinet — designed to attract everyone that comes into the store.
- Each unit is covered by a 3 month guarantee.

FREE BOOK TELLS ALL ABOUT THIS BOOMING BUSINESS

If you are interested in starting a lifetime business, then ACT NOW and send for FREE book to convince yourself that this is today's greatest business opportunity.

Model SS-1F (floor model) FAST-CHECK SELF-SERVICE TUBE TESTER $134.50 Net

Model SS-1C (counter model)
An ideal unit for shops with limited floor space. $98.50 Net

ATTENTION SERVICE SHOP OWNERS

Put the FAST-CHECK SELF-SERVICE TUBE TESTER in your shop with only a $34.50 down payment. You'll gain a valuable profit producing assistant working for you every open hour.

Do-it-yourself customers will welcome the opportunity to bring their tubes to your store where they can test tubes to their heart's content. If the tubes register "Bad" or "Weak" you are assured of profitable tube sales. And best of all you don't have to stop working when a customer brings in a bag of tubes to check. The FAST-CHECK does it all for you. If on the other hand a customer's tubes register "Good" you are on the spot for consultation or a service call.

Colorful window streamers and advertising material provided FREE by us will attract many new customers to your shop. Servicemen are not only increasing tubes sales, but are actually enlarging their service business as well, with a FAST-CHECK in their shop. Act now! Place a unit in your shop and double your tubes sales . . . save valuable working time.

TIME PAYMENT PLAN

Pay in small monthly payments at net cash prices.

NO INTEREST OR FINANCING CHARGES

CENTURY ELECTRONICS CO., Inc.

111 ROOSEVELT AVENUE
Dept. E-12, Mineola, N. Y.

Please send the units I have indicated below on your TIME PAYMENT TERMS. Include a complete plan of operation — plus all advertising material needed to get started in the self-service tube testing business. I understand no interest or financing charges will be added, and they are shipped on a 10 day money-back guarantee.

Quantity	Description	Unit Price	Extend Total
	Model SS-1F (floor model) FAST-CHECK TUBE TESTER Enclose $34.50 down payment with order for each tester. Balance payable in 5 monthly payments of $20.00 for each tester starting 30 days after shipment.	$134.50	
	Model SS-1C (counter model) FAST-CHECK TUBE TESTER Enclose $23.50 down payment with order for each tester. Balance payable in 5 monthly payments of $15.00 for each tester starting 30 days after shipment.	$ 98.50	

All prices net F.O.B. Mineola, N. Y.

Total Amount
Advance Payment
Balance

☐ I am interested. Please send me FREE book and particulars about setting-up a tube tester route. No salesman will call.

Name.....
Please Print

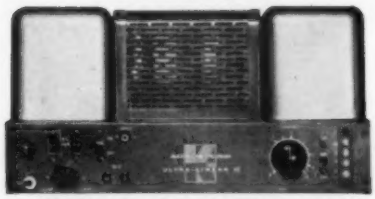
Address.....

City..... State.....

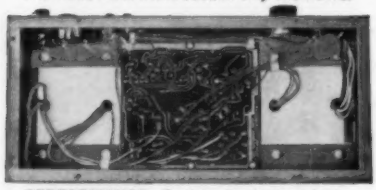
☐ ***CHECK HERE TO SAVE SHIPPING CHARGES***
Enclose total amount with order and Century will pay all shipping costs. 10 day money-back guarantee.

From
any Point of View,
more Experts choose

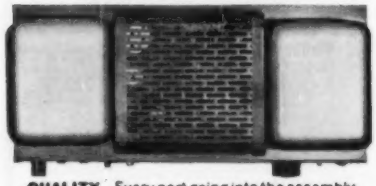
ACROSOUND
ULTRA-LINEAR II
60 watt amplifier



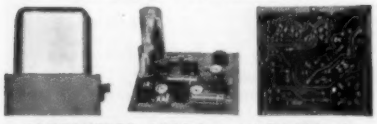
DESIGN The combination of patented ULTRA-LINEAR circuitry—plus new HYBRID FEEDBACK principle—VARIABLE DAMPING control, and ULTRA STABILITY, represents a new high in the art of amplifier design . . . an example of ACROSOUND'S latest achievement in AMERICAN Know-How. This superiority of design now enables anyone with or without any previous knowledge of electronics to assemble for himself or herself . . . (yes! it's that easy!) . . . the finest of amplifiers and at a most reasonable cost, in only two hours!



PERFORMANCE By listening test, or by instruments . . . second to none in clarity and frequency response. Normal level distortion is virtually unmeasurable—IM 1% or less at 60 watts, 120 watts peak. Completely stable . . . unaffected by loads, perfect square waves.



QUALITY Every part going into the assembly of critical and even non-critical circuitry is tested and checked to allow no more than ±½% variation from ACROSOUND'S standards. Specialized test equipment unavailable commercially was designed in ACROSOUND'S laboratories to achieve this result. Every printed circuit board is placed in trial operation on a laboratory amplifier. Output tubes are matched by trial and double checked.



COMPONENTS ACRO'S newest TO-600 output transformer with special hybrid winding—separates functions of output circuit and feedback circuit. Heavy duty, completely assembled, and thoroughly tested, printed circuit board assures uniformity of performance. Low distortion EL34 output tubes are operated well within their ratings ensuring long tube life and optimum performance.

PRICE In preassembled kit form so that you may save money, learn while doing, and have the proud satisfaction you built the best for only $79.50 net . . . or if you feel you would prefer it laboratory assembled it still represents a bargain at $109.50 net.

HEAR IT AT YOUR DEALER NOW!

BE READY FOR ACROSOUND DISTORTIONLESS PRE AMP DESIGNED FOR THE STEREO PHILE

Experts know why ACRO *is best! Others . . . Learn why! Write to*

ACRO PRODUCTS
369 SHURS LANE
PHILA. 28, PA.

NEW TUBES & SEMICONDUCTORS *(Cont'd)*

reliable operation in uhf applications. It performs dependably in amplifier and oscillator service as well as in pulse and switching circuitry. The unit is smaller than an ordinary pencil eraser.

Maximum ratings of this Motorola transistor are:

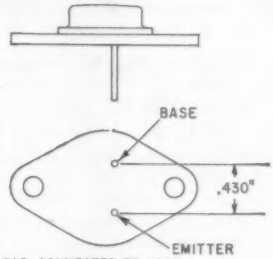
V_{CB}	30
V_{CE}	30
V_{EB}	0.5
I_C (ma)	5
Temp (junction max) (°C)	100
P_c (in free air) (mw)	50

Typical electrical characteristics of this unusual unit are:

f_{max} (mc)	600	(V_{CE}=6, I_C=2 ma)
PG (db)	12	(V_{CE}=6, I_C=2 ma, f=200 mc)
NF (db)	9	(V_{CE}=6, I_C=2 ma, f=200 mc)

2N350

A p-n-p junction transistor designed for use in audio amplifiers operating at a 4-watt output level.



COLLECTOR CONNECTED TO CASE
2N350

Maximum ratings of this Sylvania transistor at 25°C are:

V_{CB}	40
I_C (amps)	3
P_{total} (watts)	10

Electrical characteristics (at 25°C except as indicated) are:

I_{CBO} (ma)	3*	(V_{CB}=30, I_E=0)
	20*	(V_{CB}=30, I_E=0, T=90°C)
I_{EBO} (ma)	2*	(V_{EB}=10, I_C=0)
$f_{\alpha e}$ (kc) (min)	5	(V_{CE}=12, I_C=700 ma)
P_g (db)	33*	
h_{FE}	60*	(V_{CE}=2, I_C=700 ma)

*indicates maximum rating

Miscellaneous

A germanium p-n photojunction cell has been announced by *RCA*. Of the head-on type it is intended for computer, punched-card, punched-tape and sound-pickup-from-film applications. Excluding leads, the unit (designated type 7223) is only 0.580 inch long.

Zener diodes rated at 400 mw and covering a range of 3.6–10 volts were released by *Texas Instruments*. They are identified as types 1N747 through 1N758.

Bendix has put their DAP (*D*iffused-*A*lloy *P*ower) transistor on the market. It combines high power, high frequency and rapid switching in one package.

Thirteen miniature photoconductive cells have been added to the Clairex line. Two types of elements, polycrystalline cadmium sulfide, and cadmium selenide are used. All of the units are responsive over the entire visible spectrum. END

there's nothing like the feel of the right gun...

or the right TOOL!

WEN
POWER TOOLS
are "job-matched" for
easier handling, trustier performance!

Pick up a Wen tool. It fits in your hand like it grew there! Lightweight, streamlined Wen designs are extra easy-handling . . . quality-engineered to do the job right. Ask any Wen tool user. Your best dollar-for-dollar buy, too!

2-SPEED POWER DRILL
⅜" capacity in steel, up to ¾" in hardwood. Smooth easy speed change, high torque motor. $29.95

TOTER KIT
Perfect supplement to drill. 35 pieces including drill holder, Tote Box with tray. A whole workshop, only $9.95

SOLDERING GUN KIT
Includes 4 tips for wide variety of uses, solder. "Quick-Hot" gun heats in only 2½ seconds. A buy at $9.95

Barton browne advertising

See complete line of Wen power tools at your favorite dealer!

WEN PRODUCTS, INC.
5810 Northwest Highway · Chicago 31, Illinois

TECHNICIANS' NEWS

COMBATS TUBE TESTERS

To help independent service dealers recapture business lost to do-it-yourself tube testers, Raytheon Manufacturing Co. is distributing a self-service tube merchandiser–checker which service dealers may place in stores.

The Tube Mart incorporates an easy-to-use continuity tester for tube heaters and is built to display 100 tube types within easy reach. A literature rack built into the display carries Raytheon-prepared leaflets with the technician's imprint, encouraging the set owner to call the service dealer if the tube substitution does not correct the trouble.

FREE-SERVICE POLICIES IRK SET DEALERS, TOO

Television dealers are adding their voices to those of service technicians in the growing crescendo of criticism of the long-term and "free-labor" warranties being offered by some major set manufacturers and distributors.

Their trade organization, the National Appliance & Radio–Television Dealers Association (NARDA), began a series of negotiations with manufacturers for shorter warranty periods and elimination of all references to "free labor" in TV set advertising.

NARDA's view is that it's up to the dealer to decide whether "free service" should be included in the sale—and just how much. The warranty race, NARDA feels, is putting the pinch on dealers, whose service departments often must supply the "free labor" at the low rates paid by the distributor.

NARDA vice president Harold Witham told a recent regional meeting in Atlanta that "since factories cannot control the price the goods are sold for, they cannot legally or morally commit the dealer to a specified term of free service." He added that he feels most set makers are unhappy with the warranty race and would like to call it off. Like many technicians' associations, some local NARDA chapters have passed resolutions refusing to honor parts warranties which exceed EIA's standard terms of 90 days for parts and 1 year for picture tubes.

One such group—the Muskegon, Mich., Appliance & Radio–TV Dealers Association, in a letter to TV manufacturers, vigorously opposed "the extended warranties and unrealistic service rates, which benefit only the discount houses and those who sell and do not service their products." The letter noted that "the majority of electronic merchandise is still sold and serviced by independent dealers."

Technicians' associations continued to

This Complete Training in BASIC ELECTRICITY is the "KEY" you need....

to unlock the "mysteries" of RADIO ELECTRONICS

Learn your basic electricity FIRST! Learn it thoroughly! Then everything else in electronics, radio, TV, communications, hi-fi, industrial and military work and all the rest comes to you 10 times as easy . . . for they're all based on the same fundamental electrical principles! That's why this new, 396-page BASIC ELECTRICITY manual is so absolutely necessary for beginners. And it's equally important for experienced men who want to "brush up" on technical details and procedures that may be a little hazy.

BRINGS YOU COMPLETE ELECTRICAL "KNOW HOW"

including Basic Electronics . . . in one big, easy to understand home training guide

Think how often you've been "stumped" by a technical talk, by a book or by some complicated equipment—because you're not exactly clear about the principles involved! Think of the troubles you may have had with basic factors such as reactance, capacitance, impedance, phase relations, power factor, etc.! BASIC ELECTRICITY gets right down to earth in explaining every detail in ways you can hardly fail to understand.

From electrical to electronic principles, from basic circuits and currents to electromagnetism . . . from capacitance to resistance . . . from polyphase systems to phone principles . . . from ammeters to oscilloscopes to all sorts of measurements and tests . . . from tubes to transistors and all the rest, BASIC ELECTRICITY covers the entire field. Essential elements such as motors, generators, batteries and polyphase, often neglected by ordinary books, are clearly explained. And you don't need to be a mathematics expert to learn what things are all about!

This kind of training really PAYS OFF!

No matter what kind of electrical-electronic work you want to do this *BASIC* training is the most important of all. Here are some of the subjects covered:

CIRCUITS & CURRENTS • MAGNETISM & ELECTROMAGNETISM CONTROLS • CAPACITANCE INDUCTANCE • RESISTANCE PHASE RELATIONS GENERATORS • MOTORS RECTIFIERS • TRANSFORMERS WIRING • ILLUMINATION INSTRUMENTS & MEASUREMENTS • TUBES TRANSISTORS • AMPLIFIERS OSCILLATORS • X-RAYS POWER FACTOR • SERVOS INDUSTRIAL ELECTRONICS AUTOMATION

and dozens more

Don't Let Modern Circuits and Equipment "Stump" You!

More than 300 pictures, charts and diagrams make subjects doubly clear. You see how and why to make measurements by various methods. "Set up" diagrams teach you to extend meter ranges or to plan for temperature, speed, strain or thickness measurements. Dozens of basic electrical problems and their solutions are included.

Each chapter ends with a Self-Test Review of all essential points. A skilled instructor standing by your side could hardly do better!

See for yourself! Read BASIC ELECTRICITY for 10 days. If not more than satisfied simply return book and your money will be refunded promptly without question. Send coupon today to: Dept. RE-128, Rinehart & Co., Inc., 232 Madison Ave., New York 16, N. Y.

STUDY 10 DAYS FREE!

Dept. RE-128, RINEHART & CO., INC.
232 Madison Ave., New York 16, N. Y.

Send 396-page BASIC ELECTRICITY home training manual for 10-day FREE EXAMINATION. If I like book, I will then send $6.50 (plus postage) promptly in full payment. If not, I will return book in 10 days and owe nothing. **(SAVE! Send $6.50 with order and we pay postage. Same 10-day return privilege with money refunded.)**

Name.....

Address.....

City, Zone, State.....

OUTSIDE U.S.A.—$7.00 cash. Money back if you return book in 10 days.

a major breakthrough in TV-FM reception!

New JERROLD Amplified

TV-FM HOME SYSTEM

IMPROVES TV-FM RECEPTION . . . IN EVERY ROOM!

Permits simultaneous operation of TV and FM sets *in every room* . . . provides better reception from existing antenna than if each set has its own antenna! Any number of additional receivers can easily be plugged in!

- Increases enjoyment of all TV Channels, FM Stations!
- Improves Color TV, Stereo and AM Radio Reception!
- Quick, easy Screwdriver Installation in New or Existing Homes!
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fight the extended service and parts warranties, insisting the allowances paid service dealers was "unrealistic." Typical was the letter sent to all major TV manufacturers by the Radio & Television Association of Santa Clara, Calif., which said:

"The manufacturer who offers a highly unrealistic warranty compensation figure to the independent, at the same time operating his own service company to enforce this figure, cannot help but be viewed with suspicion. We believe manufacturers who use their own service organizations to stiffen unworkable warranty programs present unfair competition through real or potential subsidy. This situation constitutes a serious threat to the business future of the independent service man, and at the same time does not seem to be in the best interests of the general public."

Meanwhile, the National Alliance of Television & Electronic Service Dealers Associations (NATESA) urged an industry-wide meeting of associations and manufacturers to stop "gimmicking and carnival tactics" and return "morality and ethics to all phases of the home electronics industry." Among the practices NATESA wants to discuss are "captive service schemes by set producers on a highly uncompetitive basis, improper wholesale parts sales practices and direct sales by tube factories to outsiders" through do-it-yourself tube testers.

Unless the industry itself acts to correct these abuses, NATESA said, the independent service industry must seek an airing by government agencies and Congressional committees.

FORM COMPLAINT PANEL

Working with New York State authorities, the Empire State Federation of Electronic Technicians Associations (ESFETA) has established a statewide consumer grievance committee and has recommended legislation to protect the TV-owning public.

The grievance committee, headed by ESFETA vice president Irving J. Toner, was established at the suggestion of state Attorney General Louis J. Lefkowitz after a conference with ESFETA officers. The five association officers—Toner, president Robert Larsen, secretary George Carlson, treasurer Dan Hurley and sergeant-at-arms Frank Kurowski—were designated as grievance committee members.

All consumers are being urged to direct their service complaints to Mr. Toner's address, 703 Main St., East Aurora, N. Y., and affiliated and non-affiliated service associations are being requested to contact Mr. Toner for aid in local complaints which require the help of this state-authorized body.

In another meeting with state officials, ESFETA officers and several members proposed a state law requiring all service technicians to itemize repair bills. When a rebuilt picture tube has been installed in a customer's set, the

technician would be required to indicate this fact plainly on the bill.

The meeting was an outgrowth of an investigation by Dr. Persia Campbell of Governor Harriman's Consumer Counsel into TV-radio service in the Albany-Schenectady-Troy area. Meeting with Dr. Campbell in Syracuse were the five association officers and Don Roberts and Joseph Marotta of Syracuse, Ben DeYoung of Ithaca and Malcolm Nelson of Jamestown.

EIA ACTS TO STAMP OUT TUBE COUNTERFEITERS

A "code of ethics" for receiving-tube manufacturers, aimed at putting an end to counterfeiting practices, was adopted by the Electronic Industries Association (EIA) on the recommendation of its tube and semiconductor division, which represents the majority of tube makers.

The tube counterfeiter obtains large quantities of out-of-warranty defective tubes, washes them and re-marks them with spurious trademarks and warranty dates. He then sells them directly to the public as new tubes (often at "discounts") or turns them in to the manufacturer for new tubes, taking advantage of industry warranty policies.

The new code provides:

(1) It is the duty of the tube manufacturer to cooperate fully with legal authorities in the detection, investigation and prosecution of counterfeiters.

(2) The manufacturer must educate tube distributors, set manufacturers and distributors and service technicians about the seriousness of counterfeiting.

(3) Manufacturers should try "to put into effect wherever proper and possible the recommendations of grand juries and other public bodies" concerning counterfeiters.

(4) It is the manufacturer's responsibility to encourage the destruction of defective used tubes at all distribution levels to prevent them from getting into the hands of the counterfeiters.

(5) The manufacturer is responsible for administrating its warranty policy so as to insure that counterfeit tubes are not introduced into trade channels.

INDIANA LICENSE DRIVE

A technicians' licensing bill has been drafted by the Indiana Electronic Service Association (IESA) for introduction at the next session of the state General Assembly. IESA plans to campaign for the bill with a war chest of $5,000 to be raised by a special fund-raising committee headed by association secretary Robert M. Sickels.

As drafted, the legislation would establish a five-man board of license examiners, appointed by the Governor, with a full-time secretary. Technicians currently in business would be licensed without an examination, but those entering the business in the state would be tested, the exams weighted so that practical shop work would count 70%, technical knowledge 30%.

Licensing would be financed by annual fees of $25 from service dealers and $10 from employed technicians. Technicians practicing without a license could be fined or imprisoned. Licenses could be revoked for incompetence, unethical practices or false advertising, after a board of examiners' hearing.

TRAINING PROGRAM SET

A 4-year apprenticeship program for TV–radio technicians is being established by the Better Electronic Service Technicians (BEST) of Arizona.

Aimed at upgrading the service profession by setting standards of training and experience, the Arizona plan was formulated with the cooperation of US Labor Department officials.

It provides for a 4-year apprenticeship for new technicians, with on-the-job training periods of 6 months, each in a different shop—plus at least 144 hours a year of classroom instruction at Phoenix Technical High School or Arizona State College. Examinations will be given every 6 months to weed out apprentices who aren't progressing. Trainees' salaries will start at about half journeymen's pay, with regular raises at the completion of each exam. BEST executive secretary D. J. Gordon says the program will begin as soon as the pay scale is established.

BEST officers are Phil Prentice, president; Neil Anderson, vice president; Dick Ramos, secretary; Hal Horowitz, treasurer. END

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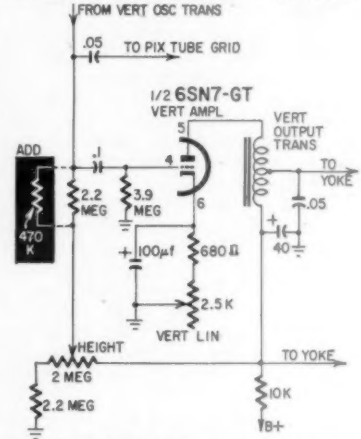
Technotes

MUNTZ MODEL M32

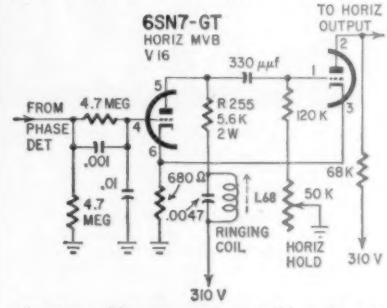
The range of the height control did not permit filling the screen. Shunting the fixed resistor in series with the arm



of this control (2.2 megohms) with a 470,000-ohm resistor made it possible to obtain sufficient height.—*Louis Sherman*

SYLVANIA 1-504-2

An intermittent raster is caused by resistor R255, 5,600 ohms, opening intermittently, breaking the plate circuit of one section of the horizontal multi-



vibrator. Always replace with a 2-watt unit. Readjusting the slug in ringing coil L68 may be necessary when R255 is replaced, to maintain horizontal stability.—*A. Phillip Monroe*

SAFETY FIRST

When making connections to a car's electrical system, it's a good idea to disconnect one of the battery cables before starting work. (The cable connected to the chassis is best.) The reason for this is that, with the cramped quarters in which such connections must be made—like under the dashboard—it is easy to induce a short circuit. Breaking the battery connection removes the possibility of flying sparks or burnt wiring while you are

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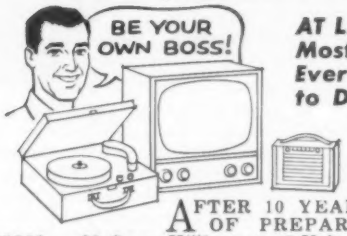

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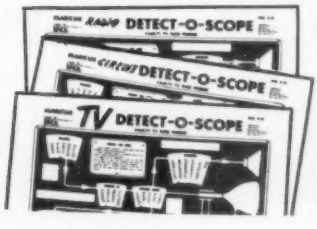

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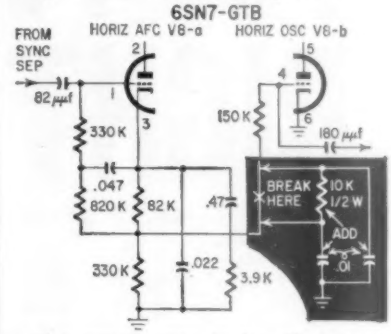
working. After the job is completed and before you reconnect the battery, check between it and the terminal with a voltmeter, with everything turned off to be sure that no wiring errors have been made. If everything is all right, the meter should read zero.—*Charles Erwin Cohn*

CBS U3T616

The complaint was bending of vertical lines near the top of the picture. As a first attempt to solve this problem, the B-plus supply to the horizontal oscillator was shunted with a 40-μf electrolytic. It failed to do any good.



The remedy was to install an anti-hook network in the afc control line to the horizontal oscillator. The line was broken at X and a 10,000-ohm resistor inserted. The ends of this resistor were bypassed to ground with two .01-μf molded capacitors.—*Lawrence Shaw*

AUTO RADIO NOISE

In the 1955 Ford, the choke cable passes over the ignition coil, through the firewall and by the radio. It is extremely difficult to reduce the resulting static. The remedy we've time-tested is to cut back the rubber on the choke cable and attach a piece of ground strap, grounding the cable directly to the firewall.—*Stan Clark* END

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Modern Electrics	1908
Wireless Association of America	1908
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Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In December, 1908, *Modern Electrics*

Wireless Telegraphy, by Melville Eastham and O. Kerro Luscomb.

Wireless on the Pacific Coast.

"Via Wireless"

Electrical Valve Tubes, by the Berlin Correspondent.

Bare Point Electrolytic Detector, by H. H. Holden.

New Detector, by H. Gernsback.

A Wehnelt-Caldwell Interrupter, by Don Banta.

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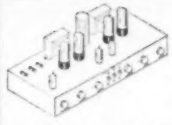

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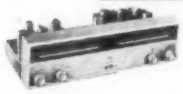

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LIGHT-BULB RESISTORS

In an emergency, electric light bulbs can be used as resistors. They also come in handy for breadboard layouts since they can dissipate heavy wattages and are easily mounted. The table compares the resistance of various bulb sizes

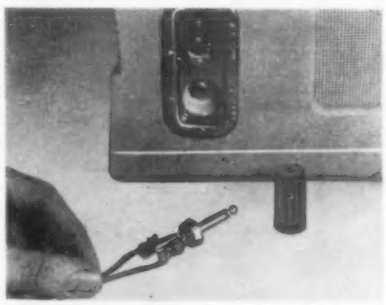
LIGHT-BULB RESISTANCE (117 VOLTS)

Bulb Size (watts)	Cold Resistance (ohms)	Operating Or Hot Resistance (ohms)	Operating Or Hot Current (amps)
7	220	2060	0.058
15	125	960	0.121
40	24	360	0.332
60	17	240	0.500
75	13	192	0.625
100	9	144	0.832
150	6	96	1.210

(wattage) at normal operating temperature with the cold resistance measured with an ohmmeter. Since the operating temperature depends on the current in amperes through the bulb, the actual ohmic value in any given application varies accordingly.—*Lt.Col. Eugene F. Coriell*

FAST PLUG CONNECTIONS

When experimenting with speaker hookups and other temporary connections involving the use of a standard two-conductor phone plug, considerable time can be saved by fastening No. 2



or No. 3 Fahnestock clips to the plug's screw terminals. Don't use this sort of convenience hookup when high voltages are involved, unless you intend being extra cautious to avoid getting bit by voltages at the exposed clips.—*John A. Comstock*

LOCKING BATTERY NUTS

To keep terminal nuts and wires on dry cells, bell and buzzer transformers, etc., from working loose because of vibration, remove the nuts and place

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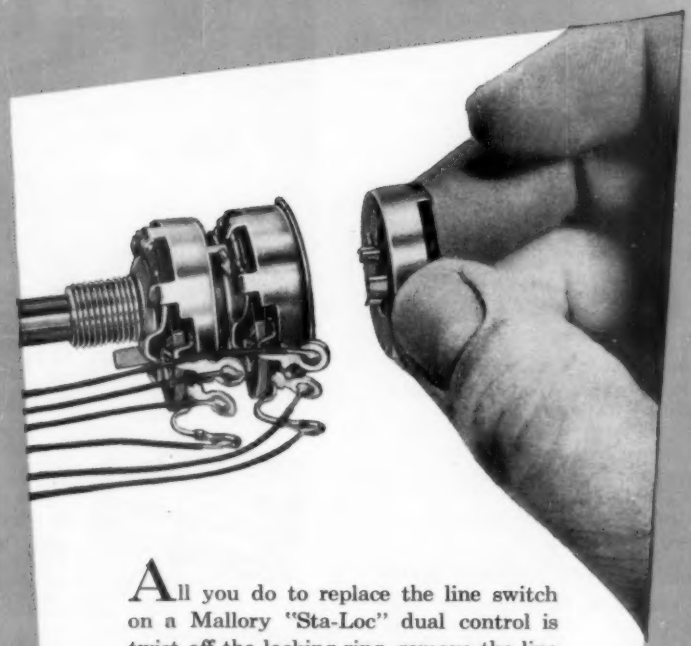

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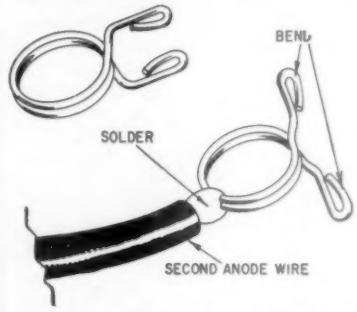
a thin brass washer and lockwasher over the wire on each terminal. This will prevent the time-consuming circuit tracing needed to uncover a loose connection. It is a real headache saver. —*Maurice Peacock, Jr.*

SECOND-ANODE CONNECTOR

A wire plate or grid cap of the type shown in the diagram is easily con-



verted to a second anode connector for a picture tube. Just bend the ends back as shown and solder the high-voltage lead to it.—*Carleton A. Phillips*

CHRISTMAS TREE LIGHTS

When trying to locate burned-out bulbs in series Christmas tree light strings, turn on your radio (preferably off station) and lightly thump each bulb until you hear a crackle in the speaker. It works about 90% of the time. When it doesn't, the filament in the bad bulb has too large a gap to arc across when the bulb is jarred.—*Carl K. Lewis*

SAVE THAT GUN

Ever pick up your soldering gun with greasy or perspiring hands and have it slip from your grasp, fall crashing to the floor and its bakelite case shatter into a dozen pieces? After this hap-

pened to me recently, I decided to prevent the possibility of its happening again. To improve my grip on the handle of the new gun, I wrapped several snug-fitting rubber bands around it. The gun hasn't slipped since.—*J. C. Alexander*

NOISY VOLUME CONTROLS

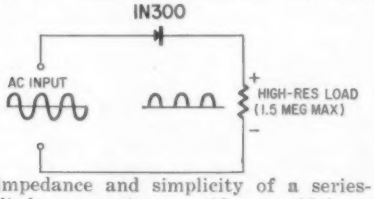
Sometimes what sounds like intercarrier buzz is caused by a dirty volume control. Cigarette lighter fluid will clean it. However, this stuff is inflammable even though it isn't toxic like carbon tet.—*John Mayo* END

NOTEWORTHY CIRCUITS

HIGH-RESISTANCE SERIES RECTIFIER

In the past, operation of light-duty series rectifier circuits employing semiconductor diodes has been limited to low values of load resistance. This restriction was caused by the relatively low reverse resistance of the diode, which means that rectification ceases when the load resistance is equal to the reverse resistance.

Circuit designers have been hampered by this limitation whenever the high



impedance and simplicity of a series-diode germanium rectifier would have been desirable.

The modern silicon junction diode, unlike its germanium grandparent, has extremely high reverse resistance and can be used in series-diode circuits with complete success. The front-to-back resistance is excellent even at high values of load resistance.

The diagram shows a simple circuit using a 1N300 silicon junction diode. Its output consists of clean half-sinusoids at load resistances up to 1.5 megohms. Comparable performance with a germanium point-contact diode only went up to 100,000 ohms.—*Rufus P. Turner*

STIFFER VOLTAGE DIVIDER

The score: half a dozen 807's with cooked screen grids, eight V-R tubes, several burned bleeder resistors and fingers. Conclusion: conventional voltage dividers and/or V-R tube regulators just won't lower 1,100 volts to 300 volts without turning the air blue. Decision: try something different that *will* work.

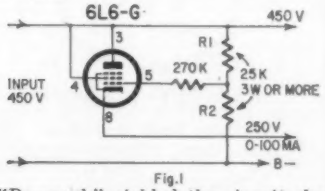


Fig. 1

"Research" yielded the circuit shown in Fig. 1,* which with the changes shown in Fig. 2 fills the bill without resorting to smoke and trips for the

*Markus and Zeluff, *Electronics For Communications Engineers*, McGraw-Hill, 1952.

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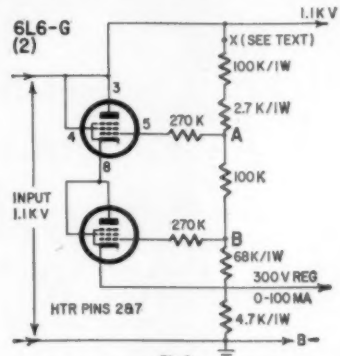

Fig.2

fire extinguisher. Note the circuit's similarity to series regulator circuits—less dc amplifier and V-R tube.

I have rigged up as many as five tubes in series, using this circuit, to drop even higher voltages to more civilized values, but each tube must have a separate, well-insulated heater transformer or disaster will strike.

Output current from 0 to 100 ma can be drawn from 6L6's in this circuit with a source impedance of about 200 ohms. Regulation against load demand runs about 1 to 2%. Changes in the high-voltage supply are reflected through the bleeder string in proportion to the drop along the string. The high-voltage supply should be fairly well filtered because of this effect, or an NE-2 neon lamp can be inserted in the string at point X. Subtract the IR drop across the NE-2 when calculating final output voltage. Voltages at points A and B should be figured 10 volts lower than the voltage desired at the cathodes or corresponding tubes.

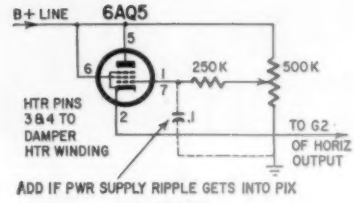

Fig.3

Current in the bleeder string is an arbitrary 4 ma for ease in figuring resistor values and lower loading on the high-voltage supply.

This circuit has been in use in a special 175-watt audio amplifier, to regulate the output stage screen voltage, with excellent results. An unexpected bonus was the protection provided the output tubes as screen voltage is not applied until the 6L6's are hot.

We've also used the circuit to cure a severe case of snivets in our TV set (see Fig. 3). A 6AQ5 was substituted for the screen dropping resistor. Bleeder resistors R1 and R2 in Fig. 1 are replaced with a 500,000-ohm pot to set the screen voltage at the proper value.

Do not exceed the recommended plate voltage for the tubes you use.—Leonard E. Geisler

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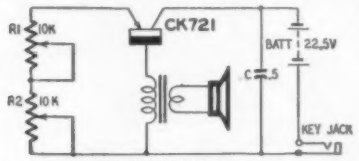
TRANSISTOR CODE OSCILLATOR

This circuit proved very satisfactory as a code-practice set. The tone variation gives the operator a good selection of signals to choose from, and the oscillator has enough output to run a loudspeaker or several headsets for duplex instruction. It uses a single Raytheon CK721 transistor.

As one current is drawn when the key is up, there is no need for an on–off switch. As with all transistors, there



R1, 2—10,000-ohm pot
C—.5 μf
V—CK721
Battery—22½ volts

is no warmup period, so the oscillator is always ready for use.

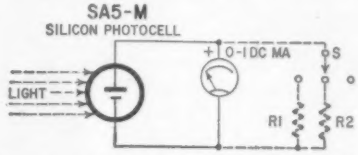
Several types of transistors were tried, and the CK721 chosen as the best for the components on hand.

With no variable controls, it is possible to use different output transformers by readjusting R2 while R1 controls the frequency of oscillation. Once the transformer is decided on, measure R2 and replace with a fixed resistor, leaving only the tone control. To keep the current at a safe limit, R2 should not be less than 3,800 ohms. —*Allan Ladd*

SENSITIVE LIGHT METER

By using one of the new, inexpensive high-output silicon solar cells, the experimenter can build a light meter using a 0–1 dc milliammeter which will provide the sensitivity formerly obtainable only with an expensive selenium cell and more delicate microammeter.

The diagram shows the simple circuit. The photocell (International Rectifier



Corp. type SA5-M) is connected directly to the meter.

Full-scale deflection of 1 ma is obtained with an illumination of approximately 70 foot-candles. Response is linear. The scale may be multiplied by connecting shunt resistors (R_1 and R_2) across the meter with a switch (S), as shown by the dashed lines. A shunt resistor of 4.5 ohms will change the full-scale deflection to 1,000 foot-candles, while a 0.85-ohm resistor will change it to 5,000 foot-candles.—*Ted Ladd*

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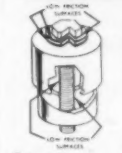

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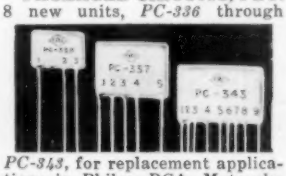

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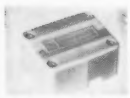

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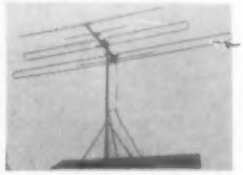

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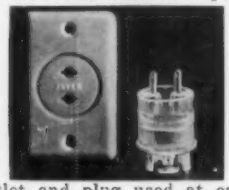

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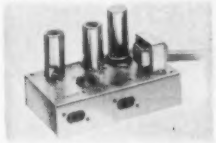
AUTO AERIAL BOOSTER, *M.V. 2* attaches between car ra-

dio and antenna for increasing sensitivity. Also substitutes for auto antenna.—**Wren Products Corp.,** 9622 Graham St., Detroit 17, Mich.

STEREO REMOTE CONTROL, kit *KT-315.* Low-impedance "plate-follower" outputs permit use 50 feet or more from amplifier it controls. Bridge circuit for precise balancing of stereo system by "audible null."

Controlled "third-channel" output for third amplifier–speaker combination.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

STEREO PREAMP, *Stereo Classic model MF-1.* 2 magnetic cartridge inputs; resistance 47K ohms; sensitivity 4 mv for 0.6-



volt output at 1 kc. 2 tape-head inputs; sensitivity 4 mv for 0.4-volt output at 1 kc; NARTB tape equalization. Response within 2 db of stated equalization characteristics. Hum and noise better than 60 db below 1-volt output. Distortion less than 0.2% harmonic at 1 kc. Better than 40-db separation between channels. Gain of channels at 1 kc equal within 1.5 db.—**General Electric Co.,** Specialty Electronic Components Dept., W. Genesee St., Auburn, N. Y.

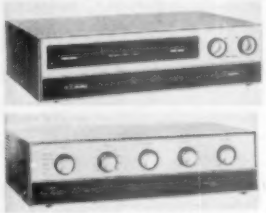
STEREO ADAPTER, *model 6.* Converts 2 preamps into

stereo control system. Monaural programs may be played from either or both speakers. Master function switch, master volume control of step-attenuator type, speaker-reversal switch, monitor switch for tape recording, master power switch. Horizontal or vertical mounting.—**Marantz Co.** 25-14 Broadway, Long Island 6, N. Y.

STEREO SPEAKER, *Goodmans' Stereosfere model S10-30.* Designed as second speaker for stereo conversions. Clean response 300–20,000 cycles. Sounds below 300 cycles channeled to

existing full-range speaker. 10 inches in largest dimension. Can be swiveled, rotated, hung from ceiling or wall.—**Rockbar Corp.,** 650 Halstead Ave., Mamaroneck, N. Y.

STEREO ENSEMBLE, *Knight KN-734* deluxe 34-watt ampli-



fier and *KN-120* deluxe basic FM–AM tuner. Amplifier delivers 17 watts from each section. Response ±0.5 db, 30–20,000 cycles. Adjustable input load for magnetic cartridges; dc preamp heater filaments. Tuner features dynamic side-

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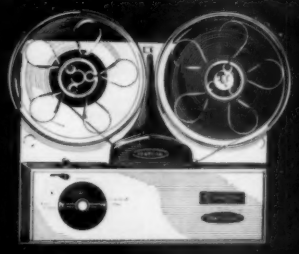

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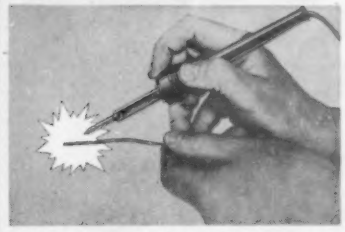

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Box 61, Baldwin, L.I., N.Y.

band regulation to reduce distortion caused by weak or overmodulated broadcast signals. Two EM84 tuning indicators. Sensitivity 2.5 μv for 20-db quieting on FM, 5 μv for 20-db signal-to-noise ratio on AM.— **Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

STEREO RECORDER, professional type, *model 300*. Push-button 3-speed model, 4-track head. Two built-in preamp and

amplifier systems; 8-watt push-pull amplifier for each channel. Records and plays stereo and mono tapes. Range 50–15,000 cycles. Dual-cone 6-inch speaker and 3½-inch tweeter. Equalization switch. High- and low-level inputs. — **Telectrosonic Corp.**, 35-18 37 St., Long Island City, N. Y.

STEREO TEST RECORD, *Audiotester*. Complete series of official standard tests for stereo and monophonic hi-fi systems. Makes possible complete check of audio characteristics "from needle to ear."— **Walsco Electronics Mfg. Co.**, 100 W. Green St., Rockford, Ill.

4-CHANNEL TAPE KIT. Head conversion kit can be installed on any Bell stereo tape transport to permit playing of 4-channel stereo tapes. — **Bell Sound Systems Inc.**, 555 Marion Rd., Columbus 7, Ohio.

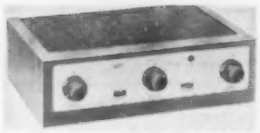
CONE PROJECTOR-SPEAKER, *model W-6*. Heavy-duty 6-inch cone type driver, horn-loaded diaphragm. Power rating 15 watts. Frequency range 140–

8,000 cycles. Impedance 8 ohms. Dispersion approximately 120°. Bell opening 15 inches, depth 12 inches. Weight 9 lb.—**Atlas Sound Corp.**, 1451 39 St., Brooklyn 18, N. Y.

COMPACT SPEAKER, *WR-8*, 8-inch unit for stereo and shelf-sized cabinets. Frequency range

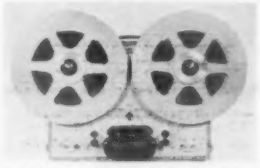
55–15,000 cycles. Resonant frequency 65 cycles. Power input 8 watts. Impedance 8 ohms. Flux density 12,000 gauss. Voice coil diameter 1 inch. — **Sonotone Corp.**, Elmsford, N. Y.

PREAMP, *Eico model HF-65*, kit or wired. Response ±0.3 db 5–200,000 cycles up to 3 volts. Sensitivity (input for 2 volts output at 1,000 cycles): low-level magnetic phono 1 mv, high-level magnetic phono 3 mv, microphone 1 mv, tape head 0.5 mv, high-level inputs 0.17 volt.



Hum and noise: magnetic phono 60 db, microphone 60 db, tape head 50 db, high-level inputs 75 db. Harmonic distortion (20–20,000 cycles) 0.1% at 3-volt output. IM distortion .07% at 3-volt output. Self-powered. *Model HF-65A* identical but takes power from any basic power amplifier. — **Electronic Instrument Co.**, 33-00 Northern Blvd., Long Island City 1, N. Y.

AUTOMATIC TAPE PLAYER, *Crown-O-Matic*. Up to 16 hours of unrepeated music with 14-inch reel at 3 3/4 ips, 8 hours



at 7½ ips. Aluminum construction. Synchronous motor. Fast forward and reverse. Automatic release for power failure. Remote reversing controls. Forced-air cooling. Magnetic brake. *Stereo-Matic* version has 4-track head and 2 output amplifiers.— **International Radio & Electronics Corp.**, Elkhart, Ind.

TRANSCRIPTION TURNTABLE with pickup arm, *model 4HF*. Wired for stereo. Variable speed adjustment on each of 4 speeds. Pushbutton system controls stop at end of record. Unit shuts off when arm is replaced on rest. 12-inch heavy-duty steel turntable has new spindle with pressure lubricating system. Professional pickup arm has

plug-in universal shell for stereo or monaural cartridges. Transcription pickup arm available separately as *model TPA/12*.— **Garrard Sales Corp.**, 80 Shore Rd., Port Washington, N. Y.

PHONO CARTRIDGE, *Heathkit MF-1*. Monaural. Diamond stylus. Low-mass, moving magnet. Weight 10 grams. Impedance approximately 5,000 ohms. Output at 5 cm/sec recorded velocity, 7 mv at 1 kc ±1 ½ db.

Vertical tracking force 2-6 grams. Nominally flat 20-20,000 cycles. Vertical compliance 1 x 10^{-6} cm/dyne. Lateral compliance, between 2.2 x 10^{-6} and 3.1 x 10^{-6} cm/dyne, depending on tracking force. Recommended load resistance 47,000 ohms.— **Heath Co.**, Benton Harbor, Mich.

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Exceptionally versatile. Basically a VFO with micro-ammeter in grid; determines freq. of other osc. or tuned circuits; sens. control & phone jack facilitate "zero beat" listening. Excellent absorption wave meter. Ham uses: pre-tuning & neutralizing xmitters, power indication, locating parasitic osc., antenna adj., correcting TVI, de-bugging with xmitter power off, determining C,L,Q. Servicing uses: alignment of filters, IF's; as sig. or marker gen. Easy to hold & thumb-tune with 1 hand. Continuous 400 kc — 250 mc coverage in 7 ranges, pre-wound 0.5% accurate coils. 500 ua meter movement. 6AF4(A) or 6T4 Colpitts osc. Xmfr-operated sel. rect. 2¼" H, 2⅞" W, 6¼" L. Satin deep-etched aluminum panel; grey wrinkle steel case.

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TV POWER TRANSFORMERS. New line of 10 universal units to fit chassis of many makes. Designated *Philco* part Nos. *322-7400* through *322-7409*. —**Philco Corp.**, Accessory Div., C & Westmoreland Sts., Philadelphia 34, Pa.

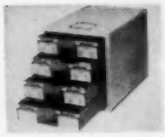
MYLAR CAPACITORS, *Gold Standard.* Critical capacitance tolerance factor of ±10%. Temperature range −30° to 85°C.

High resistance to moisture. For TV–radio replacements.—**Pyramid Electric Co.**, 1445 Hudson Blvd., North Bergen, N. J.

MYLAR TUBULAR CAPACITORS, type PM. Equal to or smaller than molded paper types of comparative ratings. For TV-radio replacements. Values from .001 to 1 μf at 100–600

volts. Temperature range −55° through 85°C at full-rated voltage. Hard thermosetting plastic case.—**Cornell-Dubilier Electric Corp.**, So. Plainfield, N. J.

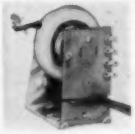
TUBULAR CAPACITOR KITS. Each kit contains widely used *type V84C* Mylar units packaged in 4-drawer metal cabinet with divided plastic drawers. *Kit AK-100* comprises 75 units rated at 600 volts in 12 most-popular values. *AK-100HS* has 76 capacitors rated at 600 volts in 14 selected values.—**Aerovox Corp.**, Distributor Div., New Bedford, Mass.



UNIVERSAL - BASE ELECTROLYTIC. *Print - Lok* line. Base fits all sets using printed-

wiring boards; also replacement for standard twist-base capacitors. Hermetically sealed in aluminum case.—**Sprague Electric Co.**, 125 Marshall St., No. Adams, Mass.

FLYBACK TRANSFORMERS.



No. HO-289 replaces RCA part Nos. 104326 and 972440-3 in 60 models in KCS113 series. *HO-290* replaces RCA Nos. 204481 and 973432-1 in 18 models using KCS109 series chassis.—**Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago, Ill.

MARKING DEVICE, *Magic Marker.* Useful in shop for preparation of schematics, marking

of test equipment, color-coding conductors and leads, etc. Available in 9 bright colors, 4 pastels. —**Speedry Products,** Box 97-RE, Richmond Hill 18, N. Y.

SOLDERING PENCIL, *Solder-Ette.* 25 watts. Easy-grip

handle. Replaceable copper alloy tip. — **Tube Wholesalers Co.**, Box 61, Baldwin, N. Y.

SOLDERING GUN, *model 8200K.* Dual heat. Trigger control gives 90 watts on first position, 125 watts on second. Prefocused spotlight. New iron-

plated copper tip for greater heat transfer and longer life. Solder, brush and *Weller Soldering Aid* included.—**Weller Electric Corp.**, Easton, Pa.

TV SERVICE CRADLE, *Universal model A.* Holds all popular-size chassis from 9- to 25-inch. Permits full 360° rotation, locks set into any position. Adjustable swivel lamp for maxi-

mum visibility. Cheater cord with switch. Built-in PM speaker with clipped leads. Mounted on 2½-inch rubber casters.—**Rogers Mfg. Co.**, 214 S. Main St., Lindsey, Ohio.

CR TUBE REACTIVATOR, *model V200.* Tests and reactivates picture tubes. "Magic-eye" indicator shows tube's re-

action to voltage, preventing overdose. Gives immediate check on functioning of grid and cathode with respect to bias

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TRC4 TRANSISTOR and RECTIFIER CHECKER

The transistor is now ten years old and is fast becoming the most talked about and used component in the electronic industry. Nearly everyone involved in electronics is finding it necessary to associate himself with the transistor and to equip his shop or laboratory with a limited amount of transistor testing equipment. The first tester that enters one's mind is one that will accurately test the transistor.

Is a Transistor Tester Necessary?

Probably the first question that you ask is whether or not a Transistor Tester is really necessary.

Actually, the answer to this is that, a serviceman or engineer can get by without a transistor tester in much the same manner as one can get by without a tube tester. You can do without it, but is saves a world of time if you have it.

Firstly, if you do not have a transistor tester, you must know the circuit that you are working on very thoroughly. Secondly, you must understand the characteristics of the transistors that are in this circuit. Thirdly, you must have the characteristic curves of each transistor that you are working on.

The TRC4 Sencore transistor tester does all of these things for you. You only need to know the number of the transistor that you want tested. The $17.95 paid for this tester can be saved after using it only a few times by preventing this wasted time.

Can an Ohmmeter or Voltmeter Be Used to Check a Transistor?

Many articles and service notes have been written on how to check transistors with an ohmmeter and others on how to check circuit voltages to determine whether or not the transistor is operating properly. The only difficulty in these procedures is that the precautions are about as lengthy as the steps themselves.

Also, the results must be interpreted properly or the checks mean nothing. Transistors can easily be ruined by accidentally applying 22½ volts to the transistor or by applying the voltage in reverse on ohmmeter checks.

Both ohmmeter and voltmeter checks are difficult to make on small portable radios. It is much easier to test the transistors first to be sure that the circuit is faulty, and not the other way around.

How Should a Transistor Be Tested?

The most scientific way to test a transistor is under a complete dynamic check with signal applied. This is impractical in many respects. To be absolutely accurate, the transistor must be checked over the range of frequencies that it is to be operated at. These frequencies may vary greatly, thus making this test very time consuming.

Also, this type tester would be very costly compared to the TRC4 shown above at only $17.95 dealer net.

FIG. 1. SENCORE TRC4 Transistor Rectifier Checker. Used and recommended by leading distributors and dealers all over the world.

In the early days of television, many TV engineers insisted that the same type check was necessary for all vacuum tubes used in TV receivers. Time has proved this theory to be obsolete as no service type tube tester was ever designed that would check tubes at their operating frequency.

The TRC4 tester works in the same manner as a quality tube tester. It applies the proper operating currents (can be considered voltage) to the transistor and measures the current gain. A second check for leakage results in a complete check of the transistor. Opens or shorts in any segment of the transistor are clearly indicated during the leakage or gain checks.

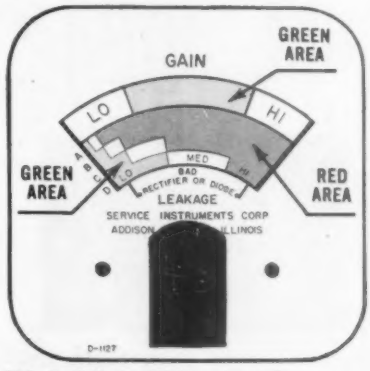

FIG. 2. Full size TRC4 meter scale.

Will the TRC4 Test All Transistors?

The TRC4 transistor and rectifier checker is designed to accurately test all types of transistors for opens, shorts, leakage and current gain. This includes the High Power transistors as used in car radio output stages as well as the small transistors as used in hearing aids. The TRC4 is the only tester designed to test all transistors both large and small.

How to Check Transistors

1. Preset the SELECTOR switch and GAIN SET controls according to the charts in the rear. See Fig. 1
2. Preset the RANGE switch to the position as indicated in the chart.
3. Plug the transistor into the socket or, if necessary, connect the test leads as shown in the base diagram at the lower right of the panel.
4. Read leakage on the scale indicated in the chart. An average transistor should read in the green area of the scale indicated. See Fig. 2
5. Depress the Gain button. An average transistor should indicate in the green area of the GAIN scale.
6. A shorted transistor will be indicated by maximum leakage reading. An open transistor will be indicated by zero gain. Unfavorable readings for both leakage and gain should be indicated before rejecting a transistor.

How to Check Rectifiers and Crystal Diodes

1. Set the SELECTOR Switch to RECT-DIODE position and the RANGE switch to the ALL OTHER TESTS position.
2. Connect the red lead to the positive end of the rectifier or diode and the black lead to the negative end.
3. A rectifier or diode with good forward current will indicate to the right of the arrow on the lowest scale on the meter. See Fig. 2
4. Depress the GAIN button. A good rectifier or diode will read to the left of the left arrow. A shorted rectifier or diode will read about mid scale. An open rectifier or diode will not read on either test.

The new dual silicon diodes should be checked with both sections in parallel. If either section is bad, the checker will detect it.

Why the TRC4 Uses a Set-Up Chart

The TRC4 uses a set-up chart in the same manner as a tube tester uses a set-up chart for different tubes. Transistors with higher current gain are biased with less base current so as to provide the same average collector current for every transistor. In this way, a single Gain scale can be used to indicate low, medium, or high gain.

The TRC4 is the only commercially available transistor tester using a set-up chart and therefore, the only tester designed to test all transistors accurately.

How to Get New Charts

New charts are printed periodically. Sencore will mail charts directly to the user upon request. A more satisfactory system of distribution is available through a registration service. If you send one dollar to Sencore, Addison, Illinois, you will receive the next six mailings of the latest transistor set up charts. This means that you will get them before your distributor.

Where to Buy a TRC4 Checker

The TRC4 Checker is available from electronic parts distributors throughout America, Canada and other parts of the world. Three out of four Industrial and Service type distributors in America have it in stock.

Over 100 are sold every working day. You can recognize them by the blue and yellow cartons and by the colorful Sencore time saver displays. Price is $17.95 Dealer Net.

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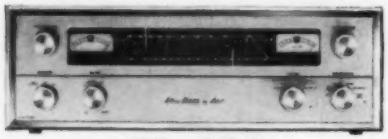

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SM-245

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PREAMP-AMPLIFIER

• stereo tuner inputs • inputs for stereo records, tape heads, recorders and microphones • tape recorder outputs • tone and balance controls • total power: 40 watts for music wave forms (80 watts for transient peaks) • less than 1% distortion at full rated output.

complete in vinyl black and gold enclosure. **$189.50**

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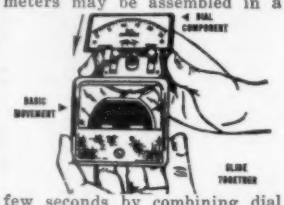
ON THE MARKET *Continued*

cutoff. Selector switch for function.—**Vis-U-All Products Co.**, 303 Fuller Ave. N. E., Grand Rapids, Mich.

CURRENT CHECKER, *model HC-6.* For fast on-the-spot

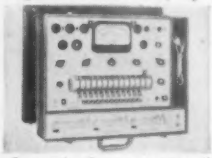
checking of horizontal output circuits without disconnecting cathode. Indicates whether cathode current is within manufacturers' recommended limits.—**Seco Mfg. Co.**, 5015 Penn Ave. S., Minneapolis, Minn.

UNIMETER. Variety of panel meters may be assembled in a



few seconds by combining dial component section with separate basic movement section. Makes possible more flexible inventory through stocking of minimum number of basic meter movements and larger quantity of dial components. Self-shielded bar-ring movements, ac and dc linear scales, dustproof. Also available in 3 standard kits.—**Triplett Electrical Instrument Co.**, Bluffton, Ohio.

TUBE TESTER, *Electronamic model 10-40.* Tests amplifier tubes over complete dynamic path of operation. Functional testing of voltage regulator tubes, beam-current test of picture tubes. Ultra-sensitive gas test. Tests all modern types, including subminiatures, by mas-



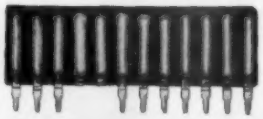
ter-element lever-operated selector system. 3-window geared roll chart.—**Precision Apparatus Co.**, 70-31 84 St., Glendale, N. Y.

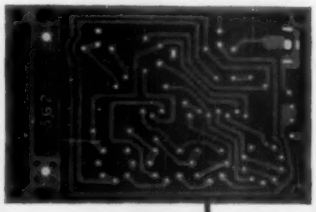
VOLTAGE STABILIZER, *T-51900.* Automatically maintains 118-volt output ±2% within 1/30 second with input variations of

from 95 to 130 volts. Designed for TV and hi-fi sets. Output capacity 200 va.—**Acme Electric Corp.**, Cuba, N. Y. END

All specifications on these pages are from manufacturers' data.

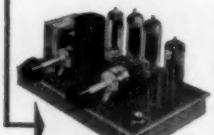
When Converting Your Phono to Stereo...Use





The ERIE AUDIO-AMPLIFIER KIT

featuring "PAC" and an ERIE Printed Wiring Board



MODEL PAC-AMP-1

With these Plug-in Components:

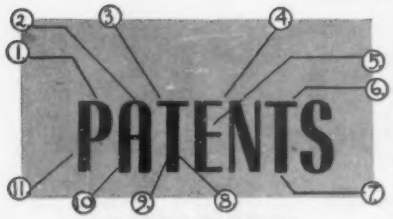
- ERIE "PAC" (Pre-Assembled Components)
- ERIE PRINTED BOARD
- OUTPUT TRANSFORMER
- FILTER CAPACITOR
- VOLUME CONTROL and SWITCH
- TUBE SOCKETS
- CAPACITORS
- TONE CONTROL
- TUBES

SPECIFICATIONS FOR ERIE STANDARD AUDIO-AMPLIFIER

- *Frequency Response:* 30 cycles to 12,000 cycles +0, —3.5 db.
- *Sensitivity:* 0.56 volt RMS (input at 1 KC) for 2 watt output.
- *Power Output:* 2 watts • *Input Impedance:* 2 megohms.
- *Output Impedance:* 4 ohms • *AC Power Consumption:* 17 watts.
- *Overall Dimensions:* 6⅛" L x 4⅛" W x 3⅞" H • *Shipping Weight:* 2 lbs.

See and hear it at your local distributor or *Write* for nearest source.

ERIE *Electronics Distributor* DIVISION
ERIE RESISTOR CORPORATION
ERIE, PA

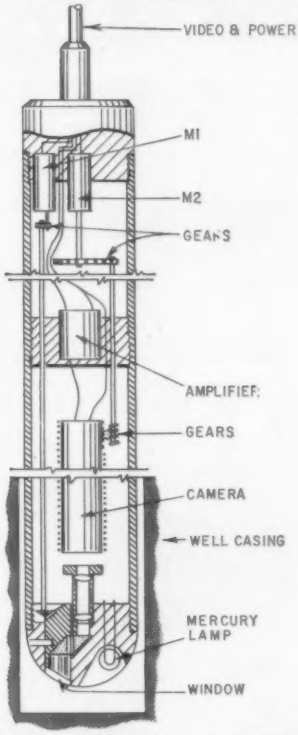


CLOSED-CIRCUIT TV SYSTEM

Patent No. 2,849,530

John H. Fleet, Taft, Tex.

Here is a novel application for closed-circuit TV: to study the interior of an oil or water well. A camera unit is lowered into the casing, while a strong light illuminates the area. The video signals are transmitted through a cable to



a distant monitor. The same cable also supplies power to the unit.

The diagram shows a typical camera unit. A mercury lamp is left exposed to the fluids in the well for cooling purposes. Reflected light is received through a transparent window, a prism and lens arrangement, and appears at the camera lens.

Motors M1 and M2, respectively, control the area being observed and the camera focus.

MONAURAL–BINAURAL SOUND BY RADIO

Patent No. 2,819,342

Floyd K. Becker, Summit, N. J. (Assigned to Bell Telephone Labs, Inc.)

Binaural sound requires two channels from microphone to speaker. One such system uses FM and AM radio transmissions. One microphone (M1) is placed on one side of an auditorium, a second (M2) is on the other side. The stereo listener (A) receives a fully balanced program, his AM speaker providing sound from M1 and his FM speaker reproducing from M2.

A monaural listener who hears a single receiver (AM or FM) cannot enjoy a balanced program since his sound originates either at M1 or M2 and some instruments appear much weaker than others. For his benefit delay networks are added as shown, and advantage taken of the "Haas effect:" when two identical sounds are heard in quick succession, the earlier one determines its apparent direction.

The delay networks do not affect the stereo listener. For example, although both his speakers reproduce sounds from M1, his AM delivers it a bit earlier so this is correctly judged

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SPECIFICATIONS

VERTICAL CHANNEL—3 stage push-pull
SENSITIVITY: DC—70 mv/in.
AC—25 mv RMS/in.
FREQ. RESPONSE:
DC—Within 3 db to 4.5 Mc.
Within 5 db at 5 Mc.
AC—Within 3 db from 1 cps to 4.5 Mc.
Within 5 db at 5 Mc.
RISE TIME: Better than .08 microseconds
INPUT IMPEDANCE: 1.5 megohms shunted by 33 mmfd
VERTICAL-INPUT STEP ATTENUATOR
VERTICAL POLARITY REVERSAL SWITCH

HORIZONTAL CHANNEL—push-pull output
SENSITIVITY: 0.6 v RMS/in.
FREQ. RESPONSE: Within 3 db from 1 cps to 400 Kc
INPUT IMPEDANCE: 5 megohms shunted by 23 mmfd
CATHODE-FOLLOWER HORIZONTAL INPUT CIRCUIT

LINEAR TIME BASE: 10 cps to 100 Kc, TV-V and TV-H, plus provisions for external capacitor sweep to 1 cps. Automatic "positive" and "negative" synchronization.

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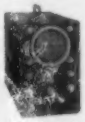
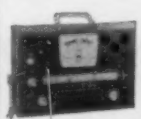
Model G-30
RF Signal Generator
Kit, Net Price: $28.50

Model M-40
High-Sensitivity V-O-M
Kit, Net Price: $31.50



Model S-50
5" Cathode Ray Oscilloscope
Kit, Net Price: $49.50



Model T-60
Tube Checker
Kit, Net Price: $38.75

Model T-65
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Model V-70
Vacuum Tube Voltmeter
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Model Z-60
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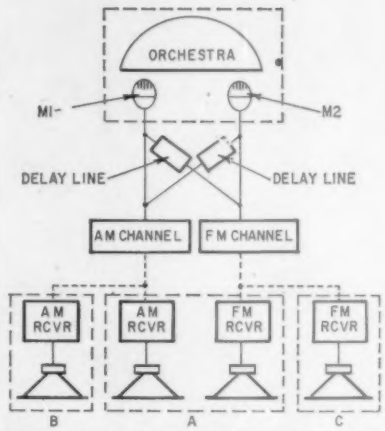
PATENTS *(Continued)*



as the sound source. On the other hand, monaural listener B or C now hears a balanced program, that is, sounds that originate from both microphones. The slight time delay is negligible.

Optimum time delay is in the range of 5–30 milliseconds.

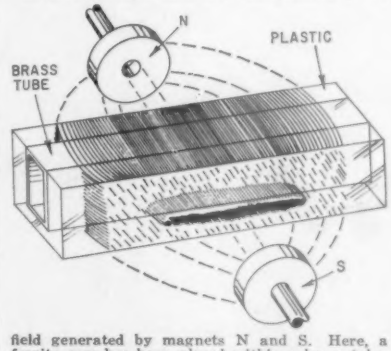
VISIBLE MAGNETIC FIELD

Patent No. 2,848,748

Lloyd R. Crump, Silver Spring Md.

This invention can help in designing coils and magnets. It discloses how to use fine iron particles immersed in liquid plastic so that a magnetic field becomes visible. Furthermore, the magnetic pattern becomes permanent when the plastic is solidified (by adding a catalyst to it). Then the plastic may be cut in various planes for analysis.

The diagram shows a typical application. The iron particles align themselves in response to the



field generated by magnets N and S. Here, a ferrite core has been placed within a brass tube, within the plastic. Note the dense field set up by the core.

The invention is also useful for toys and novelties. For example, colored iron filings can be made to form a desired shape or pattern within the solid plastic.

The inventor suggests the use of a plastic called Selectron No. 5003 (Pittsburgh Plate Glass Co.) and about 1% by weight of iron particles. He also specifies the catalyst suitable for hardening the plastic and a method for processing. END

"This gadget automatically cuts off all programs between commercials!"

BUSINESS and PEOPLE

Charles M. Odorizzi (left), executive vice president sales and services for RCA, was appointed group executive vice president, consumer products and services. He retains overall supervision of the RCA Service Co., RCA Institutes, RCA Victor Distributing Corp., and RCA Victor Co., Ltd. of

Canada. **W. Walter Watts**, group executive vice president, will head the RCA International Division, formerly under Odorizzi. He continues to head the Electronic Tube Div. and Semiconductor and Materials Div.

P. J. Casella is now executive vice president, consumer products, and will continue as president of RCA Victor Co. Ltd., Canada, and in his other executive capacities. **Robert A. Seidel**, executive vice president, is now assistant to the president and **Martin F. Bennett**, former vice president–merchandising becomes vice president–distributing.

G. Barron Mallory was elected administrative vice president of P. R. Mallory & Co., Indianapolis, Ind. He had been a director of the company and was a partner in the law firm of Brown, Wood, Fuller, Caldwell & Ivey, Mallory's general counsel.

John T. Thompson, manager of Raytheon Manufacturing Co.'s new Distributor Products Div., Waltham, Mass., appointed a new distributor product management team. In the photo, Thompson is shown reviewing sales plans with the

new group (seated left to right), **Fred H. Keswick**—dealer products manager, **John A. Hickey**—industrial products manager, **E. A. Anderson**—general sales manager, **Harold Hennig**—mar-

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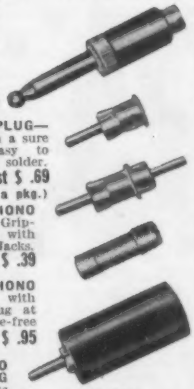
PHONE JACK TO PHONO PIN PLUG ADAPTER — Converts standard ¼" Phone Plug to RCA phono pin plug. Model PPPJ List $1.25



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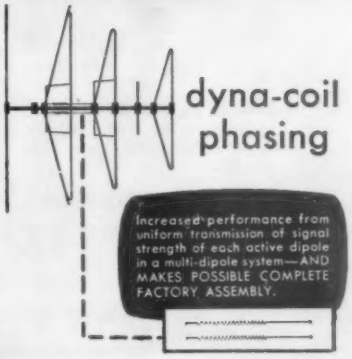
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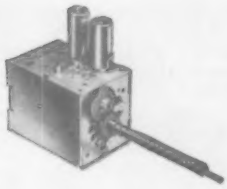

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*Subject to change

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Bloomington, Indiana

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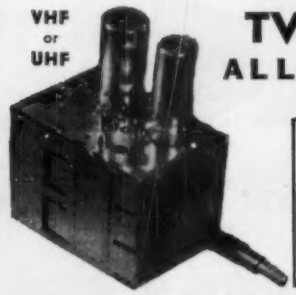

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keting research manager, **John Manchester**—controller, **William Grey**—merchandising manager, and **E. I. Montague**—director of personnel development and trade relations.

Dan W. Burns (left) and **Robert T. Campion** were elected vice presidents of the Siegler Corp., Los Angeles, parent company of Bogen and Presto Record-

ing. Campion continues as secretary of the corporation and Burns as president of the Hufford Corp., another Siegler subsidiary.

George Tallent, supervisor of quality control–semiconductors for CBS-Hytron, Danvers, Mass., was promoted to manager of quality control–semiconductors.

Donald H. Hangen, distributor sales specialist with General Electric tubes and other components was advanced to Cincinnati District sales manager for the Receiving Tube Dept.

Charles L. McCabe advances to the post of manufacturers' sales manager for Shure Bros., Evanston, Ill. He was most recently staff assistant to vice president—sales.

John W. (Jack) Merritt (left below), distributor sales manager of Howard W. Sams & Co., will assume responsi-

bility for developing a market-planning function including advertising, sales promotion, market research and merchandising. **Joe H. Morin,** general sales manager, assumes additional responsibilities for distributor sales, and **John J. Lieland** (right) becomes manager of the Publication Division.

Raytheon Manufacturing Co., Distributor Products Div., Waltham, Mass., designed a new self-service tube mer-

chandiser with a built-in tube-testing device as part of the company's new sales program, which breaks with many traditional industry distributor sales practices.

David Petrig was promoted to chief engineer of the Manufacturing Div. of ORRadio Industries, Opelika, Ala. He had been in the engineering section of the division.

Unit production and sales

First 8 months

	1958	1957
TV Set Production	2,950,455	3,756,533
Radio Set Production	6,611,686	8,765,606
TV Retail Sales	2,862,452	3,756,834
Radio Retail Sales	4,111,080	4,947,006
TV Picture-Tube Sales	4,952,862	6,236,890
Receiving-Tube Sales	251,657,000	297,281,000
Transistor Sales	25,310,834	14,611,300

Source—EIA

Heath Co., Benton Harbor, Mich., received an award from the Direct-Mail Advertising Association for its outstanding direct-mail campaign. C. M.

Edwards (left), Heath advertising and sales promotion director accepts the award from Colin Campbell, executive vice president of Campbell-Ewald Co.

Weller Electric Co., Easton, Pa., will have the World Champion New York Yankees' center fielder, Mickey Mantle, playing a part in its fall and Christmas "Weller is the Seller" promotion campaign. Mantle endorsed the entire Weller line.

ORRadio Industries, Opelika, Ala., is offering dealers of its Irish brand recording tape an animated "wire-wobbler" three-color display card illustrating the tape. END

Dynaco Output Transformers

Featuring para-coupled windings, a new patented design principle. These transformers use advanced pulse techniques to insure superior square wave performance and undistorted reproduction of transients. Dynaco transformers handle full rated power over the entire audio spectrum from 20 cps to 20 kc, without sharp rise in distortion at the ends of the band which characterizes most transformers. Conservatively rated and guaranteed to handle double nominal power from 30 cps to 15 kc without loss of performance capabilities.

Specifications:

Response: Plus or minus 1 db 6 cps to 60 kc. **Power Curve:** Within 1 db 20 cps to 20 kc. **Square Wave Response:** No ringing or distortion from 20 cps to 20 kc. **Permissible Feedback:** 30 db

MODELS

A-410	15 watts	EL-84, 6V6, 6AQ5	14.95
A-420	30 watts	5881, EL-34, KT-66	19.95
A-430	60 watts	KT-88, EL-34	29.95
A-440	120 watts	KT-88, 6550	39.95
A-450	120 watts	PP par KT-88, EL-34	39.95

(all with tapped primaries except A-440 which has tertiary for screen or cathode feedback)

Additional data on Dynakit and Dynaco components available on request including circuit data for modernization of Williamson-type amplifiers to 50 watts of output and other applications of Dynaco transformers.

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Dept. RE, 617 N. 41st, Philadelphia 4, Pa.

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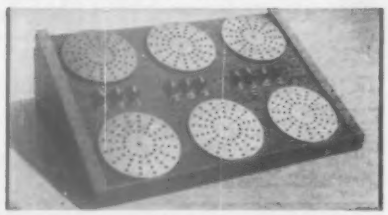

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Each kit comes complete with Beginners Manual, Study Guide, instructions for building all the machines and circuits (exclusive with our GENIAC), parts tray, and our complete question answering service. When you buy a GENIAC you are buying a first course in computer operation.

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☐ Asstd. colors, insulation. Some worth $1 ea. Wt. 2 lbs. Reg. $17 **$1**

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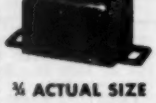

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LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

TEST INSTRUMENTS for electronic, electrical, air conditioning and heating equipment are listed with specifications and prices in 8-page *Bulletin 2060.*—**Simpson Electric Co.,** 5200 W. Kinzie St., Chicago 44, Ill.

PHOTOTUBES AND CR TUBES, plus such other photosensitive devices as photo conductive cells, camera tubes and storage tubes are listed and illustrated, with technical data and basing diagrams in large-format 32-page *Catalog CRPD-105A.*—**RCA tube distributors or RCA Tube Div.,** Harrison, N. J. **30c.**

TEST EQUIPMENT for TV, radio, electronic and electrical work is the subject of complete 8-page 2-color *Catalog 37-T.*—**Triplett Electrical Instrument Co.,** Bluffton, Ohio.

TV ANTENNAS and accessories comprising Trio's 1959 line are displayed in an attractive 22-page color catalog.—**Trio Mfg. Co.,** Griggsville, Ill.

CAPACITOR GUIDES. Replacement guide *TVR-7B* is 52-page book listing more than 3,300 manufacturers' part numbers, ratings and sizes for twist-prong replacement capacitors used in 97 makes of TV sets. Separate 22-page *Substitution Cross Index* has 3,525 listings of electrolytics to replace other makes. — **Cornell-Dubilier Electric Corp.,** South Plainfield, N. J.

ELECTRONICS CATALOG, *No. 180.* This 452-page book lists over 32,000 items, including test equipment, kits, tubes, transistors, hi-fi components and systems, industrial electronics, public-address equipment, TV and ham radio gear.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

STEREO COMPONENTS. *Catalog C-959* describes the Custom series and *Catalog P-958* the Premiere series of tuners, amplifiers and preamps.—**Grommes, Div. of Precision Electronics,** 9101 King St., Franklin Park, Ill.

SPEAKER CATALOGS. 114 replacement speakers and rear-seat speaker kits are listed in *Catalog 58.* A complete line of high-fidelity speakers is described in

Catalog 69-8.—**Quam-Nichols Co.,** Marquette Rd. & Prairie Ave., Chicago 37, Ill.

RECEIVING TUBES in the "Service-Designed" line for TV sets are now made with many of the high-reliability manufacturing techniques originally developed for military types. 24-page booklet *ETR-1541-2* explains these processes.—**General Electric Receiving Tube Dept.,** Owensboro, Ky.

TV ACCESSORIES and master TV distribution system equipment, uhf converters, boosters, etc. are included in a new dealer catalog and price list.—**Blonder-Tongue Laboratories Inc.,** 9 Alling St., Newark, N. J.

STEREO CONVERSION CHART, for wall mounting, indicates which components to add to any existing Bogen hi-fi system for conversion to stereo. Separate *Catalog Sheet No. 507* describes new stereo adapter STA1.—**David Bogen Co.,** Box 500, Paramus, N.J.

LIGHTNING SAFETY in TV antenna installations is one of the points discussed in *Lightning Facts and Figures,* published by the trade association of lightning-rod manufacturers. — **Lightning Protection Institute,** 53 W. Jackson Blvd., Chicago 4, Ill.

SPEAKER SYSTEMS, crossover networks and cabinets are featured in a 6-page condensed catalog.—**R. T. Bozak Sales Co.,** Box 1166, Darien, Conn.

INTERCHANGEABILITY CHART *ETR-1749,* listing 122 replacements for 180 popular TV and radio types, is handy pocket size.—**General Electric Receiving Tube Dept.,** Owensboro, Ky., or authorized tube distributors.

FM STEREOCASTING and the Crosby compatible multiplexing system are explained in layman's terms in an illustrated booklet, *Stereophonic Radio Reception.* — **Sherwood Electronic Laboratories Inc.,** 2802 W. Cullom Ave., Chicago 18, Ill.

SOLDERING TOOLS and accessories, including electric soldering pots and soldering pencils, are listed in a comprehensive catalog.—**Vulcan Electric Co.,** 88 Holten St., Danvers, Mass.

STATION LOG, *Jones North American AM–FM–Radio–TV Station Listings.* Lists call letters, frequency and power of more than 5,000 North American stations. Published quarterly. Back cover blank for imprinting, as promotion piece.—**Vane A. Jones Co.,** 3749 N. Keystone Ave., Indianapolis 18, Ind. **50c** each; also bulk rates.

DC POWER PACKAGES and components, *Catalog 858.* Illustrated are Tabtran chokes and transformers, filter capacitors, Tabpost 5-way binding posts, full-wave bridge 1- and 3-phase rectifiers including high-temperature Siltab units and Teksel selenium rectifier units.—**Technical Apparatus Builders,** 109 Liberty St., New York 6, N. Y. END

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use this check list when selecting the record changer for your stereo/mono high fidelity system

RUMBLE, WOW AND FLUTTER—These mechanical problems, especially pertinent to stereo reproduction, require maximum attention to design and engineering for suppression. Check the new GS-77

RECORD CARE—Dropping record on moving turntable or disc during change cycle causes grinding of surfaces harmful to grooves. Check Turntable Pause feature of new GS-77.

STYLUS PRESSURE—Too little causes distortion; too much may damage grooves. Check this feature of the new GS-77: difference in stylus pressure between first and top record in stack does not exceed 0.9 gram.

ARM RESONANCE—Produces distortion and record damage. Caused by improper arm design and inadequate damping. Check new GS-77 for arm construction and observe acoustically isolated suspension.

HUM—Most often caused by ground loops developed between components. Check new GS-77 and note use of four leads to cartridge, separate shields per pair.

MUTING—To maintain absolute silence during change cycle both channels must be muted. Check new GS-77 and note automatic double muting switch, plus R/C network for squelching power switch 'clicks.'

STEREO/MONO OPERATION—Stereo cartridge output signals are fed to separate amplifier channels. Record changer should provide facility for using both channels simultaneously with mono records. Check new GS-77 Stereo/Mono switch.

These are just a few important criteria to guide you in selecting the best record changer for your stereo and monaural hi-fi system. Some of these features may be found in changers now on the market, but only one changer incorporates them all—the modern Glaser-Steers GS-77. Only $59.50 less cartridge.

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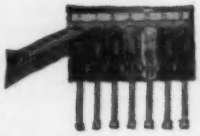

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We are happy to report that in its 8 years of existence, the Help-Freddie-Walk Fund, through the generosity of the readers of RADIO-ELECTRONICS, has contributed over $12,600 to 10-year-old Freddie Thomason, the armless and legless son of a radio technician of Magnolia, Ark.

Because he was born without arms or legs, Freddie will be dependent upon mechanical devices all his life. As we all must realize, this is an expensive proposition; for until he reaches maturity, the artificial limbs must be replaced regularly as he grows physically. It is encouraging to Freddie to know that he has the support of hundreds of friends all over the world in his struggle to become a healthy and contributing member of society.

We are fully aware of how difficult it is for most of us to put money aside these days for other than essential items, and for this reason we are more than grateful for the continued interest in the fund as evidenced by the donations we receive. We would like to say a special "thank you" to the following for their regular contributions: Meridian TV Service, Washington, D. C.; Bourell Radio-TV Service, Steele, Mo.; Fred M. Brenner, Dayton, Ohio, and Alexander Rys, Minneapolis, Minn. We also wish to thank W. E. Engdahl of Chicago for his generous contribution of $50 this month.

No amount is too small to receive acknowledgment and sincere thanks. Make all checks, money orders, etc., to the order of the Kiwanis Club of Magnolia, Ark. Send all donations to:

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c/o RADIO-ELECTRONICS
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RADIO-ELECTRONICS Contributions as of May 6, 1958	$11,898.07
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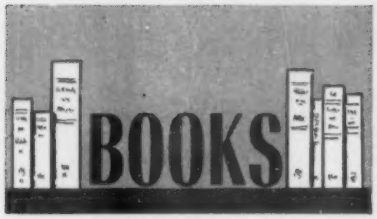
W. E. Engdahl, Chicago, Ill.	50.00
Walter R. Key, Indianapolis, Ind.	5.00
Meridian TV Service, Washington, D. C.	35.00
Alexander Rys, Minneapolis, Minn.	.20
TOTAL CONTRIBUTIONS as of Sept. 16, 1958	$12,609.77

SNOW STORM

By Jeanne DeGood

The snow is swirling through the air
With blinding whiteness everywhere—
I'm in another world, I know
Alone with blinding, swirling snow.

For snow is all that I can see
When I'm dxing on TV.



TELEVISION TUBE LOCATION GUIDE. Howard W. Sams & Co., Inc., 221 E. 46 St., Indianapolis 5, Ind. 5½ x 8½ in., pp. not numbered. $2.

The seventh edition of this guide contains tube layout diagrams, fuse information and tube-failure check charts covering a large number of TV sets, mostly 1957 models. The cumulative index also covers the six previous volumes.

ELECTROSTATICS, edited by Alexander Schure. John F. Rider Publisher, Inc., 116 W. 14 St., N. Y. 11, N. Y. 5½ x 8½ in., 72 pp. $1.35.

An easily understood book dealing with electric charges and fields. It makes liberal use of illustrations and worked-out examples, with a final chapter on electrostatic devices and applications.

HIGH QUALITY SOUND REPRODUCTION, by James Moir. MacMillan Co., 60 Fifth Ave., N. Y. 11, N. Y. 5½ x 8½ in. 591 pp. $14.

Here is one of the most informative, readable and complete volumes on sound. Its solid, practical descriptions and data should satisfy professional and amateur alike. Emphasis is on the "how and why" of hi fi, with mathematical analyses appearing in an appendix at the chapter ends.

The book begins with the nature of sound and its effects on the hearing mechanism. The various types of mikes, mixers, amplifiers, tone controls and speakers are analyzed and compared. If you are confused about relative merits and claims of different types, this book should be helpful. Disc and tape recording receive full discussion. Charts show how to design dividing networks, tone controls and equalizers. Other topics include output transformers, movie sound and stereophonic sound.

References are given at the end of each chapter, to assist the specialist and student.—*IQ*

OSCILLOSCOPE TECHNIQUES, by Alfred Haas. Gernsback Library, Inc., 154 W. 14 St., N.Y. 11, N.Y. 5½ x 8½ in. 224 pp. $2.90.

This is a book for technicians who are not content to restrict use of their scope to the simpler chores of frequency comparison, waveform inspection, amplitude measurement. The scope is a highly versatile tool, as this book shows. It can be used for curve tracing, circuit analysis and multiple-pattern displays.

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BASIC ELECTRICITY, by Abraham Marcus. Prentice-Hall, Inc., 70 Fifth Ave., N. Y. 11, N. Y. 6 x 9 in., 493 pp. $6.45.

The prolific Mr. Marcus has come up with a profusely illustrated text intended for beginners, requiring no previous knowledge of mathematics or physics. The final section of three chapters deals with electronics from the principles of electron tubes and semiconductors through radar and television. Comprehensive review questions are featured at the conclusion of each chapter.

ELECTRICAL DISCHARGES IN GASES, by F. M. Penning. Macmillan Co., 60 Fifth Ave., N. Y. 11, N. Y. 6¼ x 9¼ in., 75 pp. $3.

A comprehensive discussion of electrical discharges, including the movement of electrons and ions through a gas, sparks and lightning, the glow discharge and the self-sustaining arc discharge.

INTERNATIONAL ELECTRONIC TUBE HANDBOOK (Third Edition). De Muiderkring N.V., Nijverheidswerf 21, Postbox 10, Bussum, Netherlands. 4½ x 8¼ in., 334 pp. f. 7.50 (gulden).

An extremely useful handbook for those who occasionally deal with foreign tube types, this directory has an introduction in nine languages—and from there on uses only the universal language of electronics. It's divided into eight color-coded sections according to tube classification and contains basic data on a large number of European and American types, showing each type in a basic circuit diagram. It also contains a table of identical and similar types and a comparative table of tube designations used by British and American armed forces.

ATMOSPHERIC EXPLORATIONS, Edited by Henry G. Houghton, John Wiley & Sons, Inc., 440 Fourth Ave., N. Y. 16, N. Y. 6 x 9¼ in., 125 pp. $6.50.

The last chapter of this book should be of particular interest to the TV dx fan. It covers the "spread F" phenomenon, aspect-sensitive echoes from the E and F regions, long-duration meteor echoes and vhf scatter communications.

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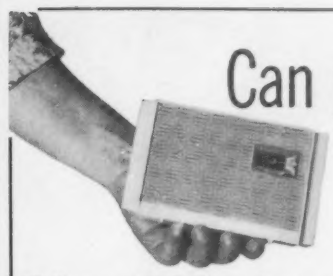

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* Construction Articles
† Section of full-length article
Clin ..... Television Clinic
Corr ..... Correction
Corres ..... Correspondence
NB ..... News Briefs
Pat ..... Patents
REC ..... Radio-Electronic (Noteworthy) Circuits
Tech ..... Technotes
TTO ..... Try This One
WN ..... What's New

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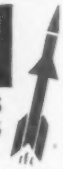

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Hugo Gernsback
Publisher and Editor

Sworn to and subscribed before me this 25th day of September, 1958.
[SEAL]
Joane Dodge
(My Commission expires March 30, 1960

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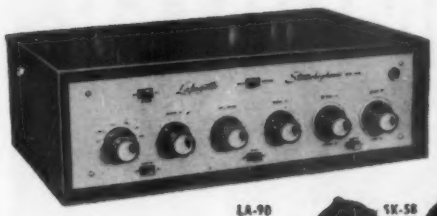
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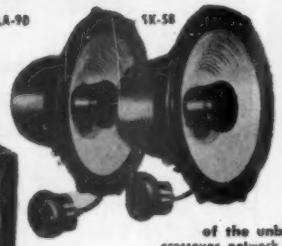
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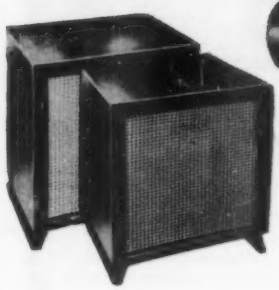
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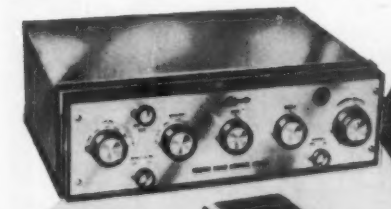
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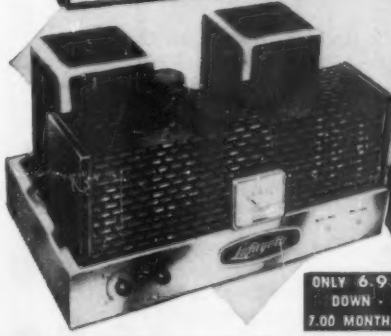
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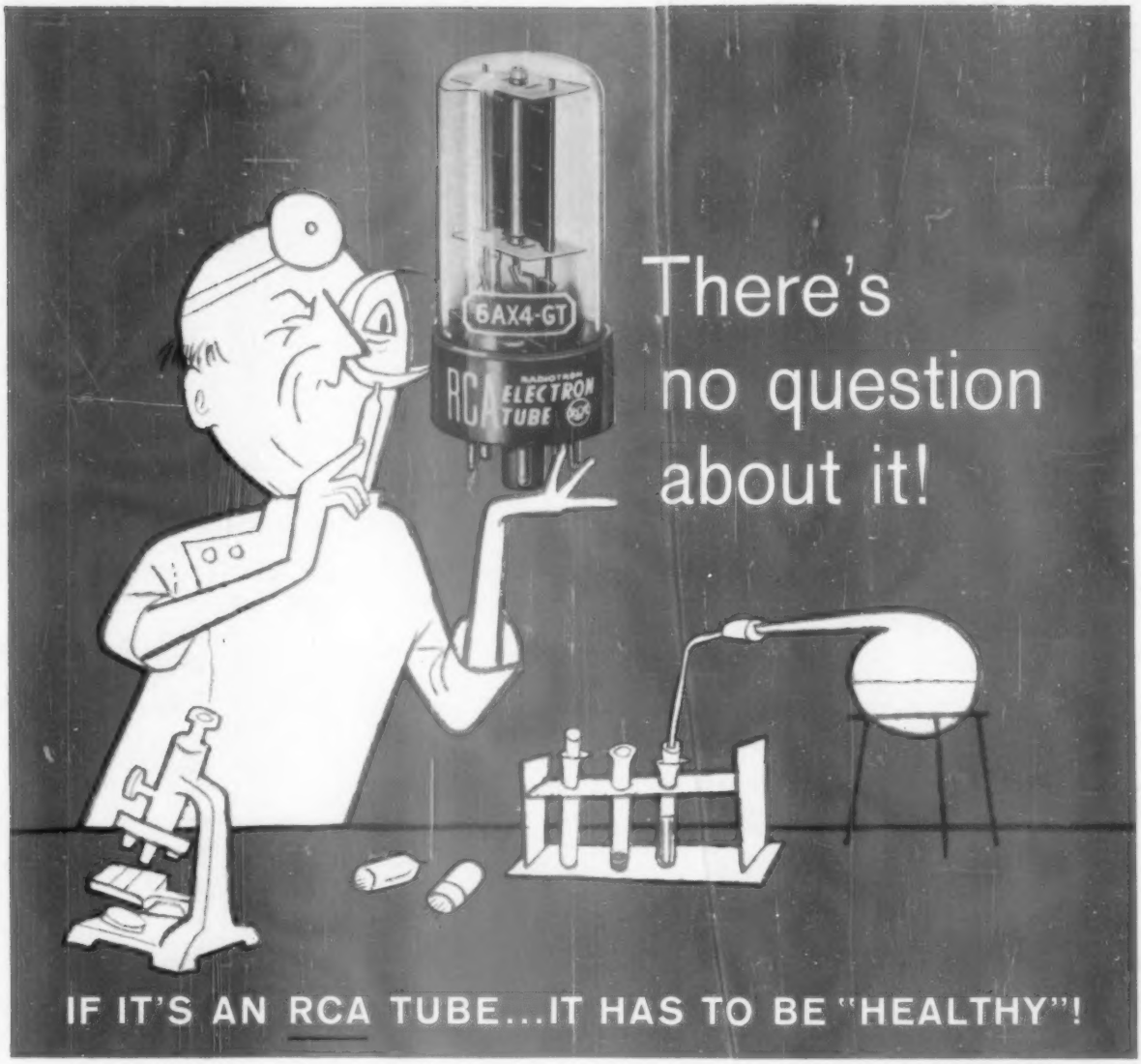
DIFFERENTIAL MICROPHONES have a noise cancelling pick-up pattern. Sound waves originating from a point more than a few inches away from the microphone enter both sides of the case at the same time and cancel each other. When sound source is close to microphone, the sound waves do not cancel. Differential microphones are ideal for use in areas of high surrounding noise.

ACOUSTALLOY DIAPHRAGM IN ALL DYNAMIC MICROPHONES Acoustalloy—the virtually indestructible diaphragm material—gives peak-free response, prevents popping on consonants. Experienced by explosive syllables 'B' and 'P' in ribbon type microphones. Because Acoustalloy gives smoother response, operators can work with confidence under rigorous program conditions.

ELECTRO-VOICE MICROPHONES FOR EVERY PURPOSE

| MODEL NUMBER | 660 | 666 | 667 | 676 | 676X | 684 | 685 | 686 | 688 | 689 | 690 | 691 | 692 | 693 | 694 | 695 | 696 | 697 | 711 | 712 | 713 | 714 | 715 | 717 | 718 | 719 | 720 | 721 | 722 | 723 | 724 | 725 | 726 | 727 | 728 | 729 | 730 | 731 | 732 | 733 | 734 | 735 | 736 |



RCA *specializes* in the production of *"healthy"* tubes. Take the RCA-6AX4-GT, for example. It features important built-in safety factors that minimize internal breakdowns and "arc-over", reducing early-hour failures—while providing reliable performance in TV damper circuits. Here are some of the ways RCA builds this "good health" into the 6AX4-GT:

Heater wire has been specially developed to improve welds, thereby reducing early-hour failures due to an open circuit at the weld point. Heater-spacer assemblies are pre-fired to eliminate leakage-producing contamination during tube production. And micas are specially sprayed to control plate-to-cathode leakage.

These are some of the reasons why many designers and manufacturers of TV sets specify RCA's 6AX4-GT—the very same reasons why you should always ask your RCA Tube Distributor to *"Ship RCA Only"!*

RCA Technical Booklet Available

RCA Receiving Tubes and Picture Tubes for AM, FM, and Television Broadcast (1275-H) . . . includes socket information and useful data for more than 700 tube types. Ask your RCA Tube Distributor for your copy today!

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